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Second National Communication of France under the Climate Convention

November 1997

ANALYTICAL SUMMARY

I. NATIONAL CIRCUMSTANCES

France's energy policy since the first oil crisis has already permitted a substantial reduction in CO_2 emissions and therefore of France's contribution to the greenhouse effect. This policy has relied in particular on the following items:

- defining strict regulations aimed at fostering energy savings. Thermal regulations on housing are a prime example.
- taxation policy. High fuel taxes, higher than in most countries in Annex 1, strongly contributed to limiting CO_2 emissions. Moreover, numerous energy efficiency tax incentives were implemented as early as 1974, in particular in industry and housing;
- a major energy saving and efficiency awareness program. Since 1974, France has an Energy Management Agency to implement these actions, it has influenced end-user energy demand and from industry, forming over time a resource of skill and expertise;
- the creation of a large nuclear industry allowing for a reduction in CO_2 emissions, not only in France, but also in other Member States of the European Union.

Considering the major efforts already undertaken and the results achieved, the cost of new measures that could be taken in France may often be higher than in other European Union countries or the OECD. This is why France considers it mandatory that the cost, per ton of offset carbon, of actions aimed at reducing emissions chosen in the national programs be similar to those of the various countries in Annex 1, in order to comply with economic efficiency and the polluter-pays principles.

II. INVENTORY OF GREENHOUSE GAS EMISSIONS

The following table summarizes all greenhouse gas emissions. This inventory is based on the CORINAIR inventory transposed into the IPCC format.

Table summary of
greenhouse gas emissions in France

	1990 Emissions (MMT)	1995 Emissions (MMT)	1990/95 Trend (%)
CO_2			
Emissions for all sectors	378	385	1.8
Energy use	357	364	2
Other emissions	21	21	0
CO_2 - Soil and forests sinks	-33	-47	42
CO_2 - Total net emissions	345	338	-1.9
(International bunker fuels - for the record)	17.5	16.8	-4
CH_4	3.02	2.84	-5.7
N_2O	0.182	0.173	-4.5
CO_2 + CH_4 + N_2O (MMT of carbon equivalent)	465	451	-3
NO_x	1.91	1.78	-6.9
VOCs	3.15	2.77	-12.2
CO	11.35	9.47	-16.6
SO_2	1.35	1.05	-22.3

(*) Global Warming Potential (GWP) over 100 years, according to IPCC 1995.

1. CO_2 emissions

Adjusted per capita and GDP unit, total net carbon dioxide emissions by France are extremely low for an industrialized country: 6.07 tons of CO_2 per capita and 0.053 tons de CO_2 per millions of FF, in 1990. Distribution by sector of CO_2 emissions generated by fossil fuel combustion was the following in 1990:

CO_2 emissions produced by fossil fuel combustion in 1990

Emitting sector	Gross emissions	Ratio to total emissions
Energy (Production et Transformation)	82 MTT	23%
Industry	50 MTT	14%
Transportation	125 MTT	35%
Domestic / Commercial	90 MTT	25%
Agriculture	10 MTT	3%
TOTAL	356 MTT	100%

The trend in net CO_2 emissions over the 1990/1995 period can be explained as follows:

- a slowdown in economic activity, in particular the 1993 recession, led to a decrease in gross CO_2 emissions, linked, in particular to lower use of fossil energy that year;
- noticeably improved availability of the nuclear power plants by "EDF" (the French Electric Utility) since 1992 permitting, all things being equal, lower use of fossil-fuel power plants;
- a continued increase in the transportation sector following the long term trend even though its rate seems to be slowing slightly ;
- the relatively strong increase in emissions in French Overseas Districts and Territories ("DOM-TOM") (+25% between 1990/1995), even though these are still relatively low (around 3 MMTC/year in 1995).
- a high increase in forests sinks, due to the combined effect of increased annual biomass production and a drop in logging, 1990 was an unusually high year for timber harvesting.

Moreover, random factors should also be mentioned such as climate fluctuation influencing heating requirements, as well as the supply of hydroelectric power .

2. CH_4 emissions

Data indicated for methane and nitrous oxide emissions are not very accurate, in particular because of uncertainties related to the assessment methods in agriculture and landfill emissions.

Methane emissions amounted in 1990 to around **3 million tons**, over 55% for agricultural activities, 25% from waste disposal activities, and especially landfill use, and over 15% of fugitive emissions from fuel extraction and distribution, remaining emissions are generated during fuel use. Methane emissions represent around 12% of direct greenhouse gases expressed in CO_2 equivalent.

Agriculture methane emissions were relatively stable over the 1990/1995 period, increased emissions related to animal waste management was compensated by a drop in enteric fermentation.

Since 1970, France has substantially reduced its emissions from coal production and gas distribution, because of the many mine closings since the early 70s and improvements in the gas distribution network.

By contrast, the increase in decaying waste in landfills contributed during the 80s to a sizable increase in methane emissions in this sector. The effect of the policy of closing landfills decided in 1992 has not yet been felt and emissions have continued to increase between 1990/95.

3. N_2O emissions

N_2O emissions amounted about **180,000 tons** in 1990, including about 50% from industrial processes and 30% agricultural fertilizer use.

Emissions between 1990/1995 changed little. A decrease in N_2O emission in agriculture should be noted, linked to a drop in fertilizer spreading, in particular in the arable crop sector.

4. Emissions de HFCs, PFCs et SF_6

In 1997 an inventory of emissions of these greenhouse gases enabling an accurate determination of the quantities released in France will be carried out.

Indications can be inferred from the French annual consumption of products causing these emissions:

- **HFC 134 - A** : 416 tons from aerosols, 166 tons from foams, 1,250 tons from refrigeration and air-conditioning;
- **HFC 143 - A et 125** (commercial refrigeration) :165 tons ;
- **HFC 23** (extinguishing agents) : 4.1 tons.

This consumption equals a *potential* in annual emissions of 0.81 MMT fossil carbon equivalent.

Indications can also be furnished on PFCs emitted in aluminum production, through anodizing : **CF_4**. Emissions of this gas were estimated by PECHINEY at 308 tons in 1990, i.e., around 0.43 million tons fossil carbon equivalent.

Finally, the volume of **SF_6** purchased annually to replace the amounts of gas lost in transportation and electric distribution equals 5.9 tons, corresponding to a likely emission of 0.04 million tons fossil carbon equivalent.

5. Tropospheric ozone precursors and SO_2

Emissions of nitrogen oxide, volatile organic compounds, carbon monoxide and SO_2 are respectively estimated at around 1.9 million tons, 3.1 million tons, 11 et 1.35 million tons in 1990. Fossil energy consumption represents by far the major source of emissions of these gases, except for VOC emissions, for which a large proportion of the emissions are from solvent use.

All of these emissions have been decreasing noticeably over 1990/1995 (between -7 et -22% depending on the gases).

III. DESCRIPTION OF POLICIES AND ACTIONS MITIGATING GREENHOUSE GAS EMISSIONS

1. Decrease in CO_2 emissions

1.1. Buildings

France has been conducting a strong energy control policy in this sector since the first oil crisis based on regulatory measures targeted at new buildings and incentives for existing buildings.

1.1.1. New buildings

As early as 1974 France took the initiative in close cooperation with the construction industry, of mandating heat insulation for new constructions. The long life-time of buildings incited France to enact even stricter regulations by anticipating constraints that will be implemented to mitigate the greenhouse effect.

- ***Thermal housing regulations will be strengthened*** as of January 1, 1999 by increasing requirements equal to the energy saved by the substitution of low-emissivity double glazing to standard double glazing. This measure represents a reduction of 5 to 10% of heating needs.

- ***Thermal regulation in the commercial sector, strongly lagging behind the housing sector, will be strengthened with the objective of reducing energy consumption by 25%.*** This will be applied before April 1, 1998 to non air-conditioned buildings and before June/1/2000 to air-conditioned buildings.

1.1.2. User information

The law on air and rational energy use of December 30, 1996 required that a standardized estimate of annual energy costs must be given when leasing or selling housing or commercial premises.

1.1.3. Existing buildings

Beginning with the first oil crisis, France developed a strong energy control policy for existing buildings and major improvements have been made. However, cost-effective energy savings still remain and this policy will be pursued through ***measures regarding user information, regulation and standardization in performances of new equipment and financial incentives for energy saving improvements.***

1.1.4. Increasing the timber use in construction

France has decided to implement a three-tiered action to develop the use of timber in construction:

- developing actions to promote timber products in construction;
- lifting factors impeding larger timber product use in construction through research, development and *ad hoc* vulgarization;
- developing a strategy of supplying of products or partially industrialized products relying on the saw mill industry.

The objective is to have an additional storage of 0.35 million tons of carbon in timber by the year 2010, compared to 1990.

1.2. Industry

Discussions with companies in energy intensive branches are underway in order to reach voluntary agreements enabling a significant use of a potential of untapped fossil carbon savings estimated at 5 million tons C per year on the basis of 1990 activity levels.
As of today, voluntary commitments have been signed with six partners (branches or industries), equal to a decrease of 1.2 million tons C per year of their emissions in 2000 compared with 1990.

Simultaneously, public support for energy conservation will be pursued in industry including financial assistance (support for research and development, support for demonstrations of exemplary investments), and tax incentives (extraordinary depreciation, exemptions or abatements in the tax base of various indirect taxes), .

1.3. Transportation

1.3.1. Freight transportation (excluding light trucks)

France has undertaken three types of actions in this sector:

- technical measures for vehicles in order to reduce specific fuel consumption of heavy trucks;
- institutional actions on the organization of freight transportation by road, compliance with social regulations, and pricing;
- an attempt to stabilize modal shares, thanks on the one hand to the development of intermodal transportation with a special focus on combined road-rail transportation and on the other hand an improvement in the network of waterways.

1.3.2. Passenger transportation and light trucks

France intends to encourage ***a reduction in average fuel consumption of new vehicles in the European Union.*** France fully supports the Conclusions of the Council of June 25, 1996 announcing the objective of an average level of CO_2 emissions for new cars sold in the European Union of 120g CO_2 per Km to be reached in 2005 or, at the latest in 2010. Pursuant to the Conclusions of the Council, this objective must be reached within the framework of voluntary agreements with the automobile industry. This is the context in which French automobile manufacturers, Renault and PSA Peugeot Citroën, have voluntarily undertaken to lower emissions of CO_2 of new vehicles sold within the European Union to less than 150g CO_2 /km in 2005. Assuming that the objective of 120g CO_2 /km will be reached in France in 2010 and the consumption of light trucks follows the same trend a reduction in emissions of around 4.5 million tons C / year can be obtained.

The law on air and rational energy use of December 12/1996 will have a major impact on road transportation pollutant emissions and, in particular, on CO_2. Among measures decided within the scope of this law, the following should be highlighted:

- measures aimed at fostering the development of electric vehicles and other alternative vehicles powered by liquefied petroleum gas or natural gas. Besides extending exceptional depreciation benefiting electrical vehicles to other alternative vehicles, to specific equipment and electric motor scooters, the main measures are the exemption or

decrease in the tax on company vehicles for electric vehicles or other alternative vehicles as well as the requirement that the various public managers of vehicular fleets to procure a minimum of 20% of such vehicles when renewing fleets;

- the requirement for all urban areas with populations of over 100,000 to draft urban travel plans. These urban travel plans, drafted and implemented by the competent authorities organizing urban travel in the relevant cities, define the principles of organization for public passenger transportation as well as for freight, traffic and parking. The urban travel plans focus in particular on automobile traffic reduction, the development of less expensive and polluting transportation modes, the development and use of the networks of streets, organizing parking, transportation and freight delivery, etc.

Finally, ***development of high speed trains*** enables offering, for intercity travel, an energy efficient alternative to using cars and airplanes. It leads to substituting electric energy for fossil energy.

1.4. Electricity production

France's unique situation with respect to electricity production, because of the importance of nuclear generated electricity, considerably lowers France's options in controlling future emission trends. ***Until the year 2010, a reduction in peak electric demand and the substitution of electricity for fossil energy for non-seasonal use will nevertheless enable limiting CO_2 emissions.*** Thus:

- ***"EDF" will offer new time-adjusted rates*** ("TEMPO" rate of 6 time periods at different prices over the year) which should allow for reduced peak electric consumption and a gain of 0.35 million tons C / year in the year 2000;
- ***Action to control electricity demand,*** launched in 1993 and ***focusing primarily on seasonal demand or demand in districts that are not connected to the continental French network*** (Corsica and French Overseas Departments), may result in additional emission reductions of 0.5 million tons C per year by 2010;
- ***"EDF" will strive to promote the efficient use of electricity in industry***;
- ***Promoting demand side management and renewable energies in low-density rural areas*** has been ensured since 1995 through the implementation of a specific installment within the scope of "FACE" (Fund for the depreciation of electrification costs); of an initial amount of 100 MFF at its creation in 1995, this installment was renewed at the 100 MFF level in 1996 and in 1997.

1.5. Increasing forest carbon sequestration

France will pursue its policy of public assistance to afforestation (assistance to planting plus an income compensation premium), with the objective of 10 000 to 12,000 ha per year over the 1990/2000 decade. This policy will contribute to accelerating the rate of increase of French forest carbon sequestration by the year 2000.

1.6. Changes in agricultural land-use

The 1992 Agricultural Policy reform should slow the trend in grassland or forest conversion into farmland—a consequence of the agricultural policy followed since the sixties. In fact, such change has not yet been observed and recent modeling studies concluded that the economic advantage attached to intensification remained sufficiently high for grassland or forest conversion into farmland to persist by the year 2000. It is therefore highly unlikely that a

reduction of soil carbon emissions, estimated at 2 million tons C per year in 1995, that should have ensued, will take place by the year 2000.

1.7. New and renewable energy

All of the measures taken in this field ***(development of wind energy, of fuelwood , in particular by the launching of a "Fuelwood Energy Plan" aimed at structuring, in a number of test regions, an effective fuelwood-energy sector for central heating, the development of agricultural biomass for energy use, energy use of waste)*** could permit saving around 1.2 million tons C / year in 2000.

2. Other greenhouse gases

Changes in emissions of these gases will be the result, in large part, of measures taken in various areas within the framework of environmental policy (law on waste mandating that ordinary waste no longer be put into landfills, law on air and rational energy use, regulatory actions concerning prevention of nitrate water pollution) or sectoral policies (in particular the Common Agricultural Policy).

Specific regulatory measures will be implemented to limit CH_4 emissions in existing landfills and N_2O emissions in industrial plants that release the highest amounts. Investments that will consequently be made in adipic acid, nitric acid and glyoxylic acid units, should lower N_2O emissions in the industrial sector by 78 000 tons of N_2O by the year 2000.

IV. ACTIVITIES IMPLEMENTATED JOINTLY

France decided at the end of 1996 to establish a mechanism for the instruction and registration of projects that could be considered for joint implementation under the pilot phase (5/CP1. 1996 decision).

V. PROJECTIONS AND ESTIMATES OF THE EFFECTS OF MEASURES

1. CO_2 energy emissions

According to the "without measures" scenario, a noticeable increase in energy consumption is observed, fueled by economic growth, in spite of an improvement in global energy efficiency. Electric consumption rises faster than global end-user energy demand, and the share of natural gas increases within the "fossil energy" subgroup. Thus energy consumption increases respectively by 17%, 33% and 50 % over the 1990/2000, 1990/2010 and 1990/2020 periods, whereas the rise in CO_2 energy emissions respectively reaches 5% and 24 % over the 1990/2000 and 1990/2010 periods. In 2020, CO_2 emissions should be higher than the 1990 reference by 46 to 71%, depending on changes in yhe electricity sector, and in particular the proportion of electricity generated by nuclear plants.

According to the "with measures" scenario, increases in CO_2 emissions will be significantly reduced; taking into account the measures described earlier in the report these should enable maintaining emissions in the year 2000 at their 1990 levels, and limiting the

increase respectively at 11% and within a bracket of 25 to 50% over the 1990/2010 and 1990/2020 periods. The global impact to the measures can be immediately inferred: it is respectively equal to 5.2, 13.1 and 20.8 million tons C / year in 2000, 2010 and 2020.

Mention should be made that at this stage the projections presented above are highly dependent on the assumptions made regarding various key parameters: economic growth[1], import costs of various fossil energies, behaviour of households ans business with regard to energy savings... For instance, economic studies suggest that potential growth for the French economy for the period 1994/2015 would be 2.6 %/year as the best guess; energy efficiency improvement observed during the 1984/1996 period was about 0.5% / year, while the sectoral assumptions made in the « without measures » scenario lead to an energy efficiency improvement of 0.65% / year for the 1990/2020 period.
Based on the latter assumptions with respect to GDP and energy efficiency, which can also be considered as realistic taking into account the slow increase in projections of energy prices, CO2 energy related emissions of France would be 4.5, 9.5 and 15% higher than the previously indicated levels for the years 2000, 2010 and 2020.

Impact of the measures in the energy sector

Mt C/an	*1990 (observed)*	*1995 (obsered)*	2000	2010	2020
Scénario without measures	100.9	-			
* low case assumption			106.2	120.1	138.5 / 164.8
* high case assumption			111.0	131.5	159.3 / 189.5
Scénario with measures	100.9	99.4			
* low case assumption			100.8	107.6	119.0/145.3
* high case assumption			105.8	118.4	138.5/168.7
Impact of the measures	-	-	5.2	13.1	20.8

Total for France for the years 1990,1995 and 2000
Continental France for the years 2010 and 2020

2. Non-energy related CO_2 emissions

Non-energy consumption-linked CO_2 emissions include:
- emissions from industrial processes;
- emissions linked to inorganic waste incineration;
- emissions linked to in land-use changes and forestry.

The most significant trend concerns sequestration in forest biomass, which should strongly increase over the 1990/2010 period (nearly 8 millions tons of C / year), thereby compensating the increase in emissions from the waste incineration sector (+2.6 millions tons of C / year over 1990/2010).

[1] A recent "INSEE" study estimates that potential growth in France by 2015 would average between 1.9 and 3.6% per year, the main estimate being 2.6%. On the basis of an elasticity of 0.5, the level of French emissions can be inferred in 2020 at between -5% and +12% of the level indicated in the table "with measures".

3. Other greenhouse gases

The most significant trends noted over the 1990/2020 period, are a strong decrease in CH_4 emissions from landfills, that should nearly disappear in 2020, as well as in N_2O emissions from certain high emitting industrial processes.

Thus, according to the scenario "with measures" aggregate emission of CH_4 and N_2O should drop from 26.3 millions tons of C equivalent / year in 1990 to 18.4 millions tons of C equivalent / year in 2020, i.e., a 30% decrease.

Trends in CH_4 et N_2O emissions

MMTCE / year	1990	1995	2000	2010	2020
TOTAL CH_4 (without measures)	*12.9*	-	*13.2*	*13.9*	*14.6*
TOTAL CH_4 (with measures)	12.9	12.9	12	10.1	9.6
TOTAL N_2O (without measures)	*13.4*	-	*12.5*	*15.9*	*20.4*
TOTAL N_2O (with measures)	13.4	12.1	7	7.9	8.8

GWP over 100 years, IPCC 1995

VI. ASSESSING VULNERABILITY AND ADAPTATION MEASURES

Since 1993, France has been expanding research and studies on the regional effects of climate change, the objective being:

- to develop plausible scenarios of trends in climate characteristics in France (including in the Overseas Districts and Territories) over the next century;
- assess the likely consequences of these changes on water resources, agriculture, forestry, coastal areas, ..., as well as their direct and indirect socioeconomic consequences;
- assess the vulnerability of the most exposed regions and suggest possible adaptation strategies.

These studies have enabled identifying a series of potential risks, which has led the relevant agencies or public authorities to start the implemention of precautionary measures such as: improved water resource management, limiting intensive cultivation, decreasing tree-density in forests exposed to water stress, choosing drought-resistant forest species for new plantings in hazardous areas, etc. These efforts will be pursued and expanded in the future.

VII. INTERNATIONAL COOPERATION AND FINANCIAL MECHANISMS

1. Cooperation with developing countries

1.1. French development assistance

Financing by industrialised countries should be encouraged for actions specifically aimed at reducing greenhouse gases emissions of developing countries, but it is certainly just as important to strive to accelerate the development process of these countries: indeed, demographic trends are, over the very long-term, the major factor of future emissions of greenhouse gases and though development will not be sufficient to control population growth, it represents, nevertheless a necessary condition thereof.

France is one of the most generous countries in terms of official development assistance (ODA). In 1995 it became the second donor country in the amount of assistance furnished, at 8.4 billion dollars. France is ranked first among the 7 most industrialized nations (G7) in percentage of Gross Domestic Product (GDP) allocated to official assistance. France spent 0.55% of its GDP on its ODA effort in 1995, the average for OECD countries was 0.27%.

Net contributions of France under bilateral assistance reached 32 billion French francs in 1995, i.e., the equivalent of 76% of its total ODA.

In the field of the environment and sustainable development, France's action is guided by the principles expressed in 1992 at the Rio Summit, viewing the evolution of our planet within a sustainable development perspective. Within this framework, social and economic development must be linked with long-term management of the local and global environment, with the goal of avoiding any irreversible action. These concerns find especially suitable applications in developing countries. In Africa, in particular, contrarily to what is taking place in our industrialized societies, natural resources (underground, soil, plants, continental and maritime waters) represent most of the productive base. Therefore, the stakes, simultaneously with a diversification of their economies, are to promote forms of resource management that ensure lasting resources.

This action is aimed at the following objectives:

- supporting the sustainable development of partner countries in the sectors of activity where the long term stakes are particularly important, for example in situations where anthropogenic action can lead to irreversible degradation,
- support consideration for environmental criteria in bi- and multilateral development assistance projects, and the implementation of a sectoral environmental policy within French and international development assistance institutions.

All the instruments of French assistance have gradually acquired the means to carry out environmental assessments; the proportion of projects completed in the environmental sectors is increasing. For example, in 1995, environmental operations programmed by the "CFD" (French Development Bank) in Foreign states represent 1.65 billion French francs, i.e., 28% of the programs. In 1995, after three years of testing, an environmental mechanism was integrated into the project cycle at the "CFD".

France allocated 10 billion French francs in financial resources in 1995 under multilateral assistance.

France is participating in all the multilateral development assistance mechanisms. France in all international forums responsible for multilateral instruments shows the same determination to grant multilateral assistance the financial, institutional and management means absolutely necessary for conducting assistance efficiently.

In particular, France is attached to the principle of balanced burden sharing, the cornerstone of the multilateral system; France backs establishing enough financial resources for international financial institutions, the implementation of institutional reforms when needed, and that these institutions define operational strategies in conformity with the objectives of sustainable development, focusing efforts on the least developed countries, and combating poverty and respect for the environment.

With respect to environmental protection, France supports a strengthening of the activities and financing of multilateral organizations directed towards sustainable management of natural resources as well as better integration of environmental concerns at the planning stage of development projects.

1.2. French assistance for global environmental protection and climate change prevention

France initiated the establishment of the Global Environment Facility which finances incremental costs in development projects related to global environmental preservation. Established on a pilot basis in 1990 and restructured in 1994, the GEF was funded with 2 billion dollars for the 1994-1997 period. France, with 807 MFF, is the fourth contributor to the GEF. As of today, 47% of the GEF's funding has financed projects concerning the greenhouse effect.

France established in 1994, in addition to its funding of the GEF, a French Global Environment Facility (FGEF), funded with 440 MFF, over the same period. The FGEF has 44 projects, reflecting a programming capability of 202 MFF; 51% of the financing is, as of today, directed towards the greenhouse effect, within the scope of the 21 projects. This funding complements measures and assistance and cooperation projects for combating the greenhouse effect conducted by French assistance partners.

Finally, French assistance plays an especially important role in the forestry area, in particular in Central Africa, which includes both the financing of support and investment projects by the "CFD" and the Ministry of Cooperation and the implementation of scientific cooperation programs (the French Center for International Cooperation for Agricultural Science and Development "CIRAD", and the Overseas Territories Scientific Research Agency "ORSTOM").

2. Cooperation with countries in transition to market economies

2.1. Ensuring nuclear safety

France, in close cooperation with Germany has played a leading role in cooperation led by the international community, over the last four years, supporting the improvement of nuclear safety in the Central and Eastern European Countries and the former USSR. Thus, France is making a financial effort of 360 MFF (for 1993/1996) to the International Fund for

Nuclear Safety in Eastern Europe managed by EBRD, and 150 MFF, for bilateral cooperation actions.

This cooperation essentially concerns operational safety, improvement in technical features and strengthening of the regulations applied to nuclear plants. The goal pursued by these actions is to avoid a new accident with serious direct consequences that could consequently slow nuclear development, even where it is designed and operated safely, and to preserve non CO_2 generating electric production, which is currently offsetting he production of 60 MMTC per year in the relevant countries.

2.2. Energy savings and decreases in natural gas leaks

In all Eastern European Countries, it is estimated that 30% in energy savings can be obtained by implementing practices used in the West. Actions financed on French funds on a bilateral basis are often a first stage of a mechanism relayed by multilateral financing (World Bank, EBRD, PHARE and TACIS Community programs). Nevertheless, for these various actions to be really effective, energy consumers in these countries must be made aware of the need for energymanagement, and in Russia, such awareness requires that fuel prices rise closer to world prices.

Active cooperation is developing also in the area of natural gas under the impetus of *"Gaz de France"* (The French gas utility company) which has been striving since 1991 to convince partners through various operations (training, demos...) of the efficiency distribution methods using polyethylene networks.

VIII. FRENCH CONTRIBUTION TO RESEARCH ON GLOBAL CLIMATE CHANGE

1. Global climate change

Research at the international level was first focused on physical, chemical and biological aspects enabling the study of human-induced climate trends, by establishing the World Climate Research Program (WCRP) followed by the International Geosphere-Biosphere Program (IGBP). In 1995 the ICSU decided to sponsor with the ISSC the International Program on the Human Dimensions of Global Change (IPDH) which will redefine it objectives.

French research organization followed the international model, but in order to stress the fact that climate change and global environment is the result of all types of interactions of elements of system Earth, these were regrouped within a single program under the French IGBP which included national participation in WCRP and IGBP. Current changes in this program take into account international changes and in its new composition, the Scientific Committee of the new Research Program on Global Change (former IGBP) includes representatives from the social sciences, i.e., covering the 3 major international programs.

All the programs related to the Environment were recently substantially reorganized within the National Center for Scientific Research ("CNRS"). This organization covers aspects of local environment that do not relate to Global Change.

2. Research on emission reductions

"ADEME's" (the French Environment and Energy Control Agency) mission is to facilitate and stir technological research in the fields of new and renewable energy and to promote energy savings in industry, transportation and construction. Nearly one billion French francs have been allocated in funding for these actions in the Agency's budget from 1990 to 1996.

Moreover, the National Agronomic Research Institute ensures the coordination of a research program on the level and emission (or sequestration) conditions of greenhouse gases in connection with rural sector activities, to which several public research organizations contribute. This program has enabled, over the 1992/1994 period, the implementation of 17 million French francs in public funds. Up to the year 2000, public financing of 9 millions francs is being considered for this program.

INTRODUCTION

Confirmation of the threats on climate caused by increases in greenhouse gases emissions, in particular CO_2 (IPCC's Second Assessment Report, 1995) has led the French government to pursue its policy of climate change mitigation, in application of the precautionary approach.

The commitment of the French authorities is reflected through active participation at the international level, in particular within the scope of the United Nations Framework Convention on Climate Change and the negotiation of a protocol or other legal instrument with the goal of adopting in Kyoto, at the end of 1997 appropriate measures for the period beyond the year 2000.

The commitment to enact policies and measures to limit CO_2 emissions and other greenhouse gases that are not regulated by the Montreal Protocol, contained in Article 4, paragraph 2 of the Convention, shall be carried out at the European Union level, by the Union and its Member-States acting within the scope of their respective competences. Initiatives that are currently decided at the Community level are indeed extremely important and effective in many fields such as transportation, fuel taxes, various regulations (in particular in the environmental area) and the Common Agricultural Policy. In addition to its commitment as a Party to the Convention, the European Union decided on its own, in 1990, to meet the goal of stabilizing its CO_2 emissions at the 1990 level, by the year 2000. France, for its part, made the commitment that its CO_2 emissions would not exceed 2 tons of carbon (7.33 T CO_2) per capita and per year in 2000.

The First National Communication of France under the Climate Convention was completed in February 1995. Studies conducted at the time suggested that policies and measures included in the French program for the prevention of climate change would enable France to reduce its global greenhouse gas emissions (CO_2, CH_4 and N_2O) in the year 2000 to their 1990 levels. The trends observed over the 1990/1995 period, as well as the conclusions of the new projections presented in Section V of this document, indicate that these predictions should be fulfilled. Therefore, the Second National Communication contains relatively few changes in comparison with the first report on the "policy and measures" aspect.

In March 1997, the European Ministers of the Environment proposed to reduce greenhouse gas emissions in the industrialized countries by 15% in the year 2010 compared with 1990, as well as an internal allocation of the effort creesponding to a reduction level of 10%. This allocation acknowledges the specificity of the French situation—including the extremely low level of its greenhouse gas emissions per capita or per unit of economic activity in 1990: the effort asked of France is to stabilize its emission between 1990 and 2010.

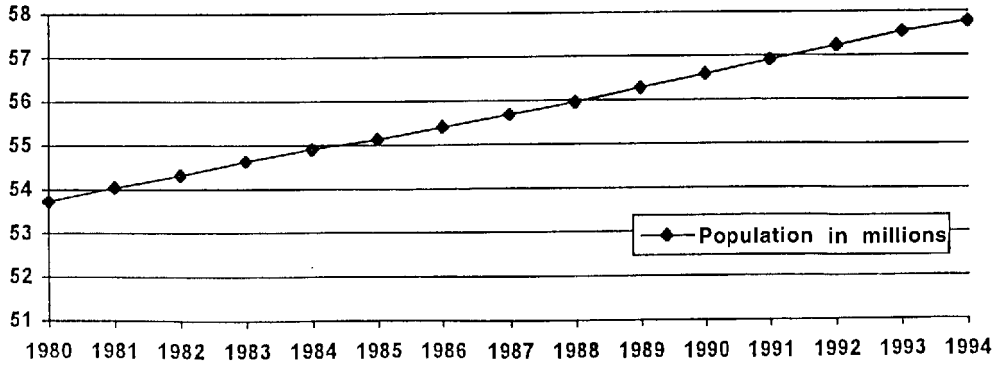
Moreover, the Ministers also concluded that over the longer term, the allocation of reduction objectives among industrialized countries should be worked out to eventually lead to a convergence of emission levels based on appropriate indicators. France will strive to defend this principle in international negotiations underway and in the future, in order to ensure required fairness in the international allocation of the global effort to reduce greenhouse gases.

I. NATIONAL CIRCUMSTANCES

1. Demographic profile

The French population grew from 50.5 million in 1970 to 58.3 million in 1996. Figure 1 shows the French population trend from 1980 to 1994. Population growth in 1995 was slightly below 0.5%. In 2025, France should have a population of 64 million.

Figure 1: French population trend (source: INSEE)



French population density is near average within the 15 EU countries: 106 persons per km^2. This average density masks, however, major disparities. Population is mostly concentrated around large urban and industrial centers (Paris region, Rhone and Alps, Lower Seine, Marseilles urban area), around the former mining basins (North and East) and along the Mediterranean coast. The 1990 census revealed that large urban areas of more than 200,000 people were growing faster than average-size cities.

2. Geographic profile

France is a large country within Europe. Its land area (550,000 km^2) is the largest among the 15 EU members. It therefore has varied geographic characteristics.

Situated between the Atlantic Ocean and the Mediterranean Sea, France has 3,200 km of coastline. Altitudes are average, plains and hills cover 2/3 of the territory, there are however two mountain barriers in the East and the South: the Alps and the Pyrenees. The highest peak in France is the Mont Blanc (4,807m) in the Alps, on the border with Italy. The Massif Central, a Hercynian massif situated in the center of the country, is the high runoff point of the 4 major watersheds: the Seine in the North, the Loire in the North-West, the Rhone in the East and the Garonne in the South-West.

French territory is covered by 80% farmland and forests. However, between 1982 and 1990, urban landscapes have strongly increased: + 23.5% for built areas, +17% for non-built areas and +9.7% for roads and parking.

3. Climate profile

French climate is subject to three climatic influences, oceanic, continental and Mediterranean.

The Western area is under oceanic influence: low summer/winter temperature contrasts.

Rennes 1961-1990	
Average temperature (°C)	**11.4**
Rainfall - Annual total (mm)	**648.8**
Sunshine- Annual total (h)	**1851.2**
Frosts - Annual number (days)	**38;6**

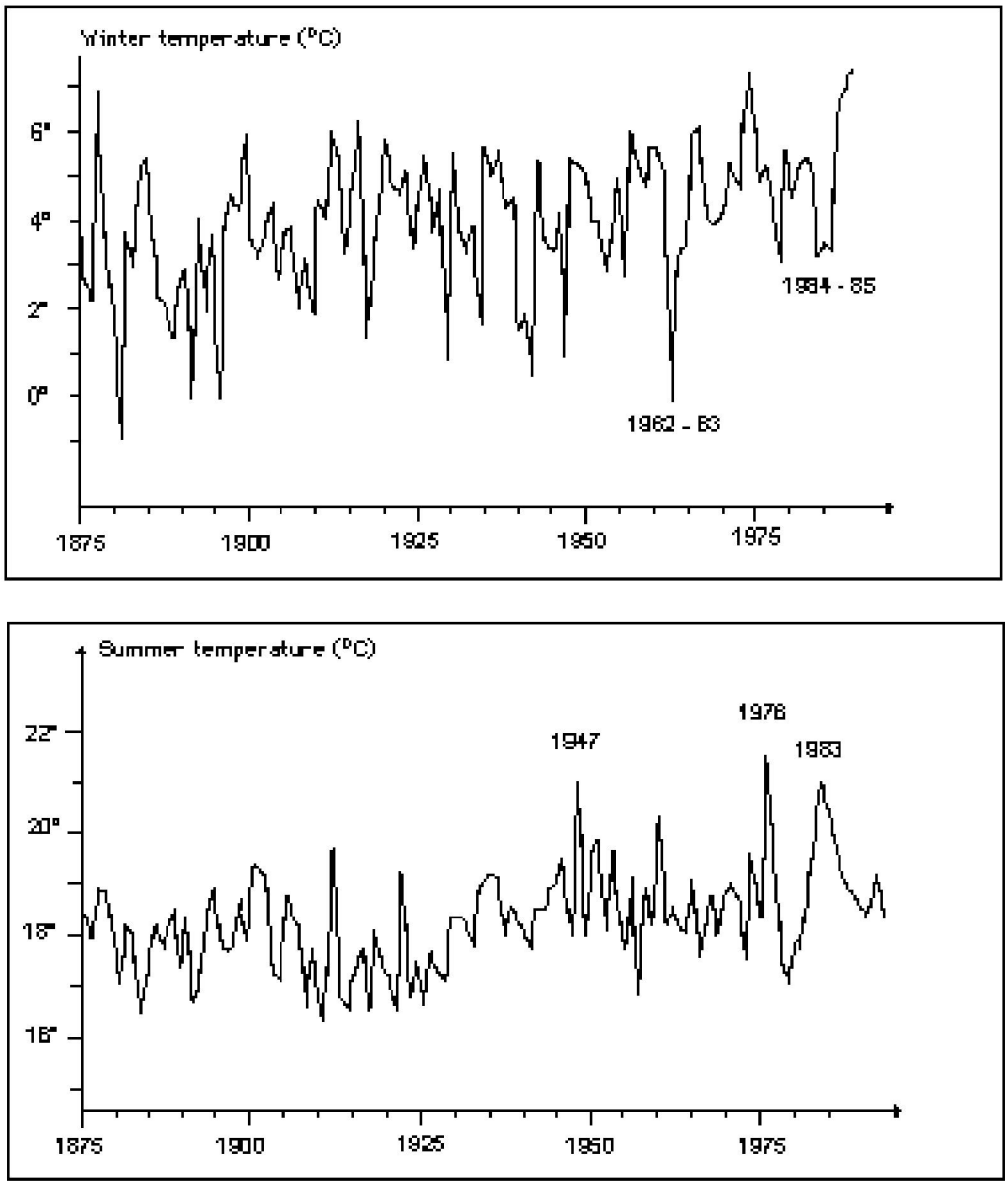
The continental influence prevails in Eastern France: winters are harsh and summers hot and storms are frequent.

Nancy 1961-1990	
Average temperature (°C)	**9.6**
Rainfall - Annual total (mm)	**759.3**
Sunshine- Annual total (h)	**1651.5**
Frosts - Annual number (days)	**79.4**

Southeastern France enjoys a Mediterranean climate: it features dry, warm summer and mild winters. There is heavy spring and fall precipitation.

Marignane 1961-1990	
Average temperature (°C)	**14.8**
Rainfall - Annual total (mm)	**544.4**
Sunshine- Annual total (h)	**2835.5**
Frosts - Annual number (days)	**25.8**

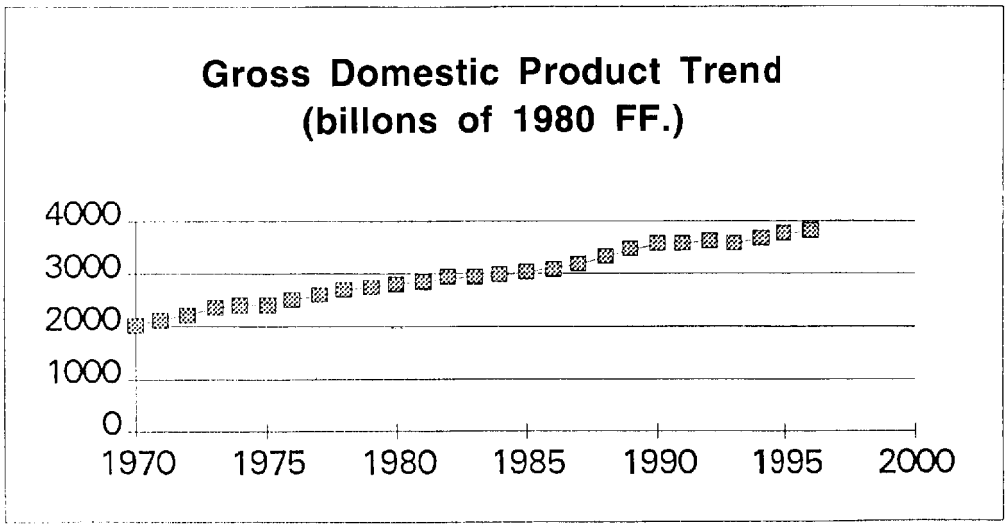
Figure 2 : Temperatures recorded in Paris-Montsouris since 1875
(source : Météo France)



4. Economic profile

The GDP trend in France from 1970 to 1995 is illustrated in Figure 3. Average annual growth was equal to 2.7% over the period. Per capita GDP was 127,628 French francs in 1994.

Figure 3



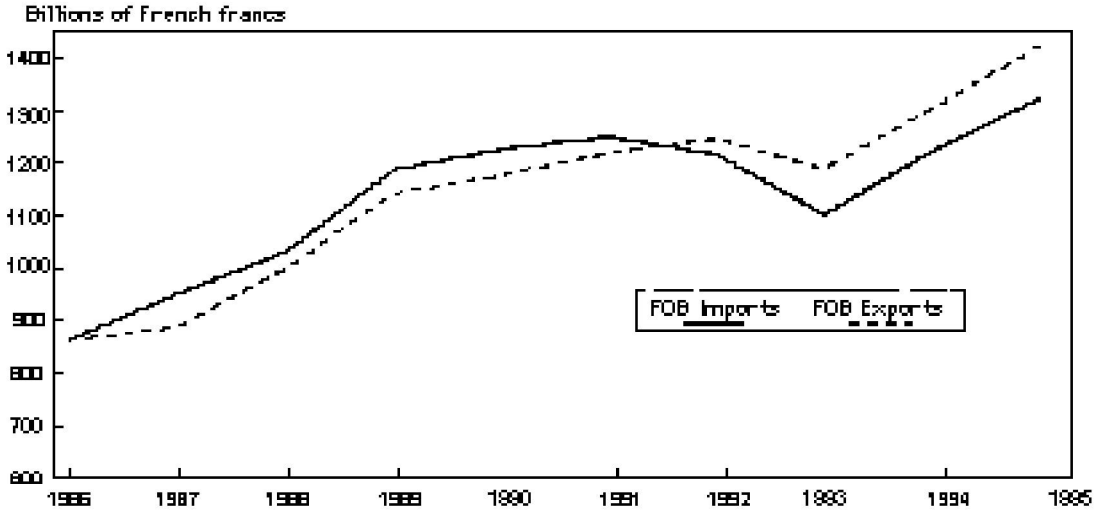
Commercial services contribute the most to GDP, with 19.5% of the total. In fact, around 63% of the GDP comes from the service sector (commercial services, trade, real-estate rental, transportation and telecommunications...). The secondary sector is mostly represented by the intermediate goods industry, professional equipment and consumer goods (between 4 and 5% of the GDP each).

4.1. Foreign trade

Since 1986, France's foreign trade has increased overall, even though the foreign trade figures dipped during the 1992-1993 recession. Since 1991, the foreign trade balance has been favorable.

Professional equipment, chemical products and consumer goods represent both France's main imports and exports. At the foreign trade balance level, agricultural produce and the agrofood industry's products represent the largest favorable balance. Contrarily, France is running a high foreign trade deficit in energy products. In 1995, 63.6% of France's foreign trade was with its 15 European Union partners.

Figure 4: France's foreign trade, FOB/FOB trade
(source: French Ministry of Economy and Finance)



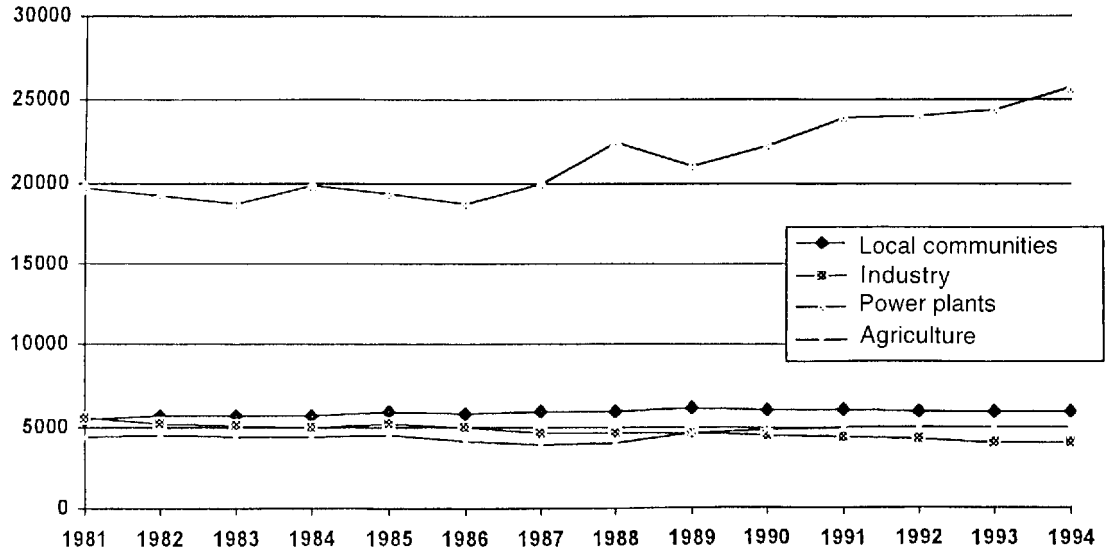
4.2. Use of natural resources

Productive agricultural land (PAL) has decreased by 7% between 1970 and 1995. The farmland structure has also changed, tending towards a decrease in grassland pasture (permanent grasslands) and an increase in acreage of oilseed and protein crops. Permanent grasslands have diminished from 41 to 31% of PAL between 1970 and 1995 while at the same time gains, oilseed and protein crops rose from 35 to 44% of PAL.

Public funding for agriculture reached 71.6 billion French francs in 1995, most aimed at market stabilization and to encourage certain produce (77% of the total).

Irrigated farmlands have increased from 539,000 ha in 1970 1,620,000 ha in 1995. Power plants are using more water than agriculture. This is caused in large part by the expansion of nuclear generated electricity.

Figure 5: Total water withdrawals by usage
(in million of cubic meters, source: Ministry of the Environment)



5. Energy profile

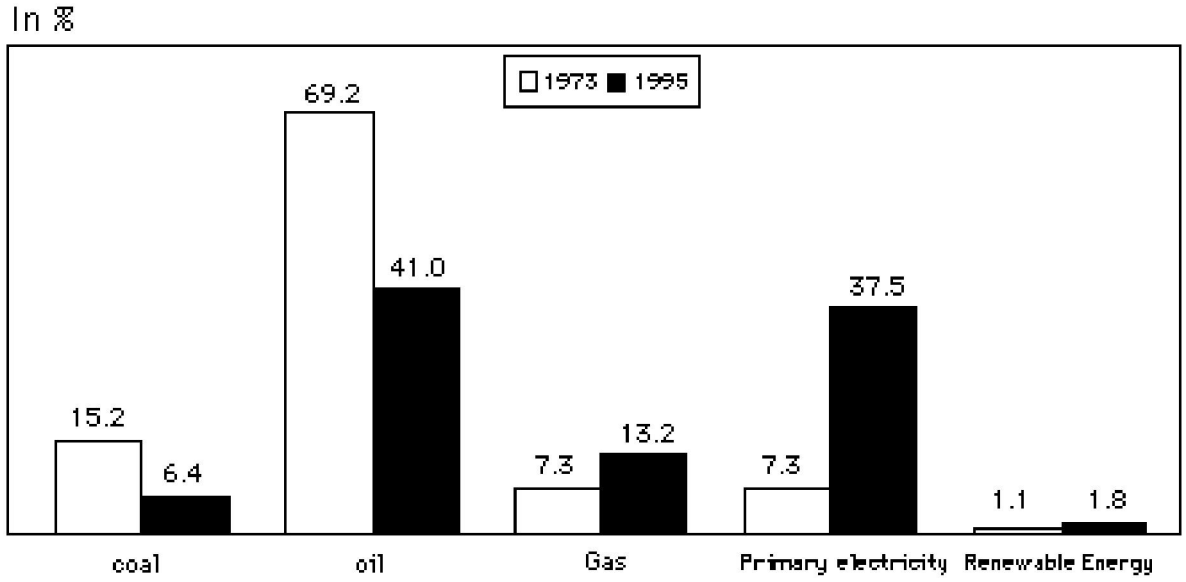
From 1973 to 1995, French primary energy production has increased by 178% thanks mostly to a very high increase in nuclear generated electricity (+2436%). In 1995, nuclear energy represented 72% of primary production, whereas it represented only 8% in 1973. Consequently, natural gas (-57%) and coal production (-68%) have dropped considerably. Hydropower production has been very stable. Geothermal or wind energy has remained marginal in overall French energy production.

Changes in production patterns have increased France's energy sufficiency rate from 22.5% en 1973 to 51.4% in 1994.

Consumption of primary energy has increased in France from 25.3% between 1973 and 1995. The proportion of the four major energy sources in consumption has followed the trend in production patterns, with a drop of 47.5% for coal, and a rise of 547% for electricity. Electric consumption is now equal to oil consumption. These two sources represent nearly 80% of French consumption. In spite of a strong decrease in French production, natural gas still represented a consumption of 13.2% in 1995, increasing by 128% since 1973.

Energy consumption has increased strongly in the transportation sector (+49%). It represents over one quarter of French consumption and is now higher than the industrial sector (excluding the iron and steel industry). The residential and commercial sectors remain at 45% the largest energy consumer. It has grown by nearly 50%. Consumption in the industrial sector has remained stable, but its share has decreased. It represents less than one third of French consumption.

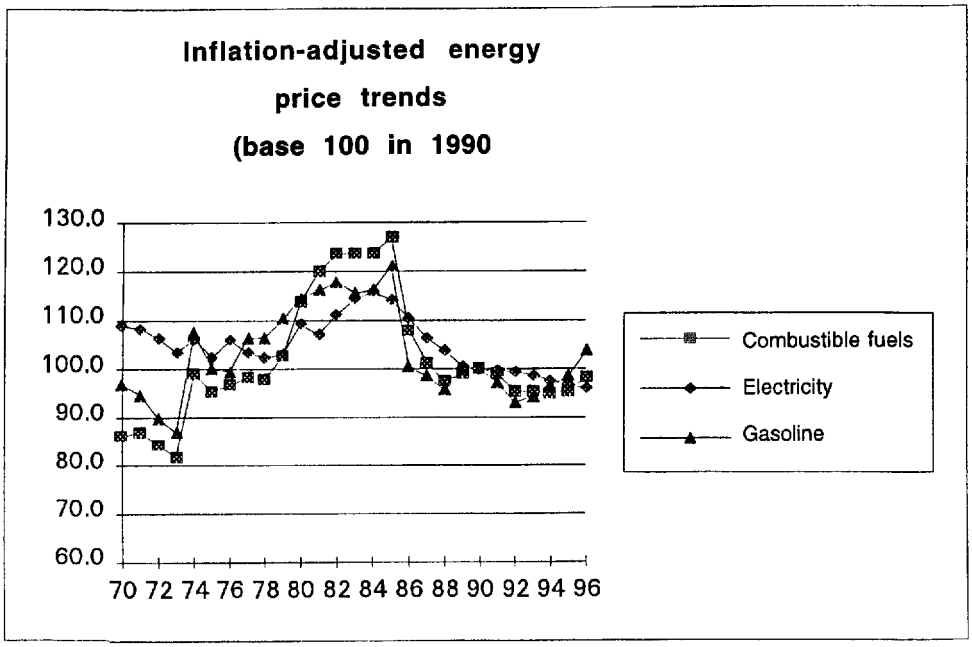
Figure 6: French consumption distributed by energy type
(source: "Observatoire de l'Energie", excluding fuelwood/energy outside commercial distribution)



End-user energy intensity has decreased substantially in France since the first oil crisis (-32% between 1973 and 1992); around 40% of this trend can be explained by the structural changes in the French economy, which is gradually moving towards less energy intensive activities. This structural change at the level of domestic production was followed by a similar change in national consumption patterns: if energy intensity is calculated in a "closed economy" model (by reintegrating in the national energy consumption and national GDP, the energy consumption caused by or offset by the industrial added value of foreign trade), practically no variation is shown compared with the value obtained in an "open economy" model (+4% compared with the latter) and over the period 1973-1992 these two indicators grew closer until they nearly merged. *Gains realized by France in energy efficiency over the 1973/1992 period are therefore not due to the "exporting" of its high energy consuming activities.*

As for energy prices, Figure 7 shows that they have increased substantially since 1973, date of the first oil crisis. Only in 1985 did prices start to fall and stabilize.

Figure 7



6. Social profile

Average housing space per capita has increased by 21.9 m^2 in 1970 to 34.1 m^2 in 1992. At the same time as housing became larger on average, more comfortable and newer, while households became increasingly smaller, i.e., 2.1 persons in 1992 versus 3.1 in 1970.

In 1993, more than three-quarters of households (78%) owned at least one car. This percentage has grown very slowly in recent years, whereas multiple-car ownership has increased noticeably: 27.5% families owned at least two cars in 1993, whereas only 18% did in 1981.

For travel within a range of less than 80 km, on a week-day, passenger cars are used in 63,5% of the cases (1994 data), whereas in 1982, cars were used in only 48,7% cases. Public transportation use has changed little, rising from 8.5% in 1982 to 9% in 1994. Walking and two-wheeled vehicle use has been penalized by the increased use of passenger cars (-52% for two-wheeled vehicles, -32% for walking).

For freight transportation, road traffic reached 115.3 billion tons per kilometer in 1993. The major products transported were machinery, vehicles and manufactured goods (30.8 billion tons per kilometer) food and fodder (26.8 billion tons per kilometer).

Rail traffic reached 43.6 billion tons per kilometer in 1993, including 11.6 billion tons per kilometer for machinery, vehicles and manufactured objects.

Figure 8 : Domestic transportation trend (basis 100 1n 1970, source: "DAEI/SES", "INSEE")

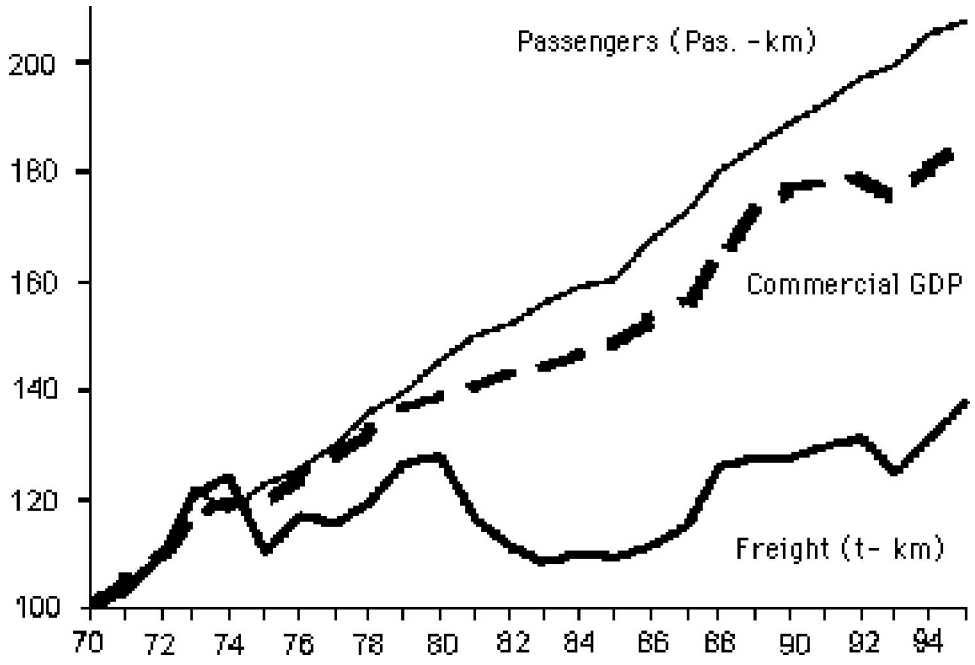


Table 1: Domestic passenger transportation trend
(in billion passenger-kilometers, sources: "SNCF, RATP, DGAC, DAEI/SES")

	1991	1992	1993	1994	1995	1995
	%	%	%	%	%	level
Passenger cars	2.3	3.0	2.1	3.4	2.0	664.3
Buses, coaches	3.9	-2.6	0.5	1.5	-4.9	40.5
Rail transportation	-2.2	1.1	-6.1	0.5	-6.5	64.5
Air transportation	-0.3	2.8	1.1	2.8	1.1	12.3
Total	**1.9**	**2.5**	**1.2**	**3.0**	**0.9**	**781.6**

7. Public institutions and administrative organization

France is a Republic, with a regime that is considered presidential. The President of the Republic appoints the Prime Minister and cabinet members, as proposed by the Prime Minister. The government (currently, 17 full-fledged ministers) "determines and conducts national policy".

Parliament (National Assembly, the lower house; Senate, higher house) holds legislative power. However, practically speaking, the government has a lot of influence on the legislative process (proposed laws, option of law-making through ordinances...).

France is a country with a strong centralizing tradition. However, in 1982-1983 decentralization laws were implemented granting greater powers to local authorities (in continental France: 22 regions, 95 districts and 36,560 communes). Because there are so many

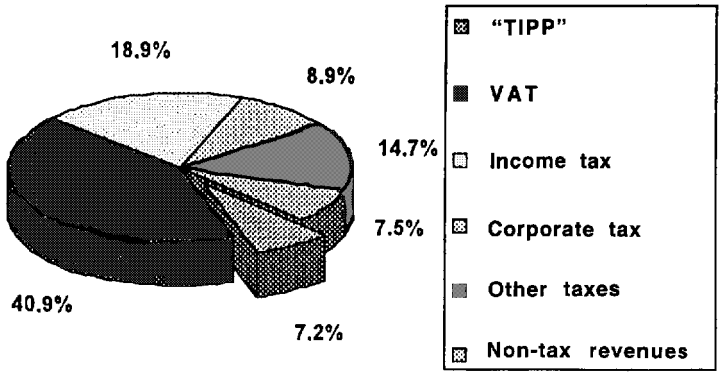
small communes the public authorities have been inciting them to regroup in order to carry out their duties. For example, the regrouping of communes is a common practice for waste management, water distribution or sanitation and urban transportation, etc.

7.1. Energy sector

The main energy tax in France is a domestic tax on petroleum products ("TIPP"). It represented in 1996, 148.9 billion French francs, or 10.9% of the state's budget income.

In early 1997, the proportion of various levies and taxes in the sales price of premium gasoline equaled 77.4%. It was 67.4% for diesel fuel. This taxation differential, and therefore, the price gap between premium and diesel fuels encourages an increase in diesel powered cars in France.

Figure 9 : Allocation of state budget income in 1993



The nationalization laws of April 8, 1946 had a great impact on the electric and natural gas industry.

Electric production management was transferred to "Electricité de France" ("EDF") by the nationalization law, as well as distribution (except in a few rare exceptions, "EDF" controls, for example, 94% of the electric supply).

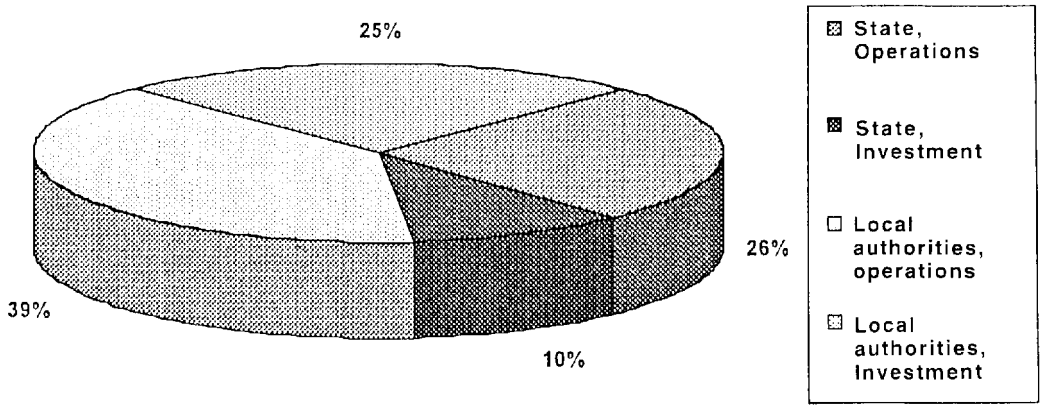
Combustible gases were similarly transferred to "*Gaz de France*" ("GDF"). However, today "GDF" is mainly involved in transportation, storage, marketing and distribution of gas in France. In France, 4 main companies produce gas: Elf-Aquitaine, Esso-Rep, Eurafrep and Coparex.

7.2. Transportation sector

In 1995, public administrations spent 204 billion French francs on transportation, i.e., around 8% of their expenditures, versus 10% in 1970. The state is becoming less involved while local authorities, following the decentralization laws are taking over.

Rail transportation operations represent 35% of state spending and 29% is spent on road transportation. Spending being equally divided between investment and operational costs.

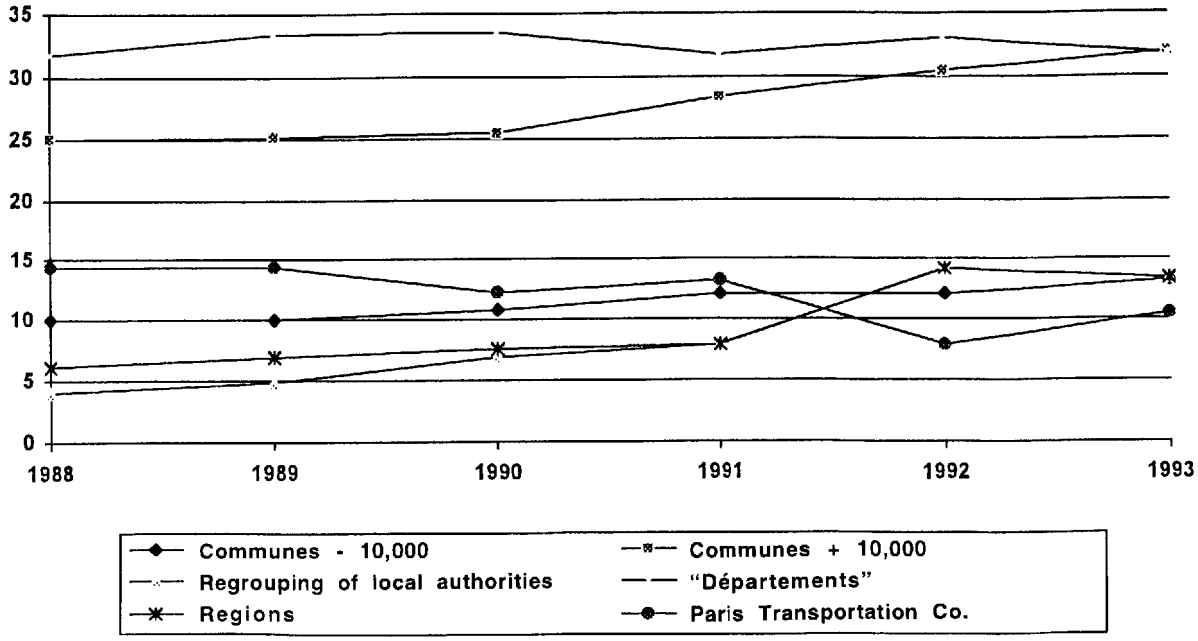
Figure 10 : Allocation of transportation spending in 1993 (source: "INSEE, DAEI/SES")



In the transportation sector, road infrastructures are the largest sector in which local authorities are involved (65% of spending, 50% for investment and 50% for operations) followed by urban public transportation (35%, 20% for investment and 80% for operations).

The regions whose role has increased since the decentralization laws, are beginning to invest in major road and rail infrastructures within the framework of contracts signed with the state and the "SNCF" (The French National Rail Company), (mainly the "TER"—regional express trains—and even the very high-speed "TGV" trains for the "Eastern TGV"), because these operations are carried out under economic development policies. Likewise, major provincial urban areas, faced with urban congestion problems, have strongly invested in public transportation.

Figure 11 : Transportation spending by local public administrations
(en billions of francs, source: "INSEE, DAEI/SES")



8. Greenhouse gas emissions

France's energy policy since the first oil crisis has already permitted a substantial reduction in CO_2 emissions and therefore of France's contribution to the greenhouse effect. This policy relied in particular on the followed items:

- defining stringent regulations aimed at fostering energy savings. Thermal housing regulations are a prime example.

- taxation policy. The high taxes on fuel, higher than in most Annex 1 countries, has contributed to a great extent in limiting CO_2 emissions. Moreover, many tax incentives aimed at improving energy efficiency have been implemented as early as 1974, in particular in industry and housing.

- a major energy saving and efficiency awareness program has been implemented. France has had an Energy Management Agency since 1974 to implement these actions, and that acts on end-user demand and from industry, forming, over time, a resource of skills and expertise.

- the development of a large nuclear industry enables reducing CO_2 emissions, not only in France but in the other Member-States of the European Union.

Considering the major efforts already undertaken and the results achieved, the cost of new measures that could be taken in France may often be higher than in other European Union countries or the OECD. This is why France considers it essential that the

cost, per ton of offset carbon, of actions aimed at reducing emissions chosen in the national programs be similar to those of the various countries in Annex 1, in order to comply with economic efficiency and the polluter-pays principles.

The following charts illustrate the trend in CO_2 emissions over a long-term period linked to the use of fossil energy. *Specifically, these are CO_2 emission linked to the use of fossil energy in continental France, adjusted for climate variations and integrating international bunker fuels.* Even though these do not entirely comply with the methodology recommended by the IPCC, these graphs still give a good indication of long-term trends in French CO_2 emissions.

Figure 12

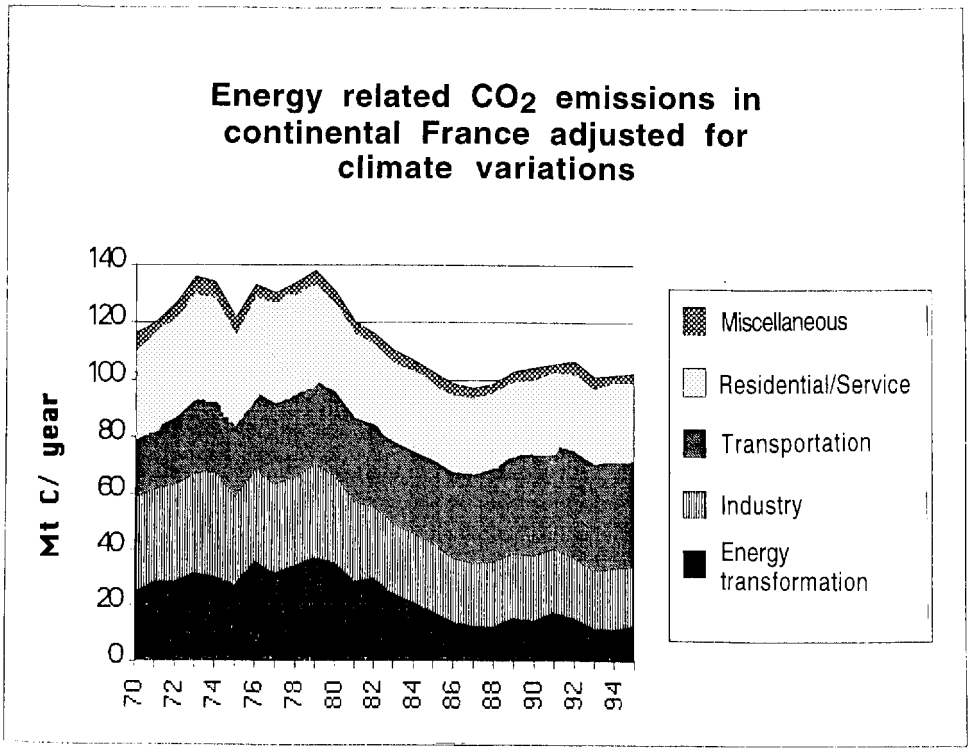


Figure 13

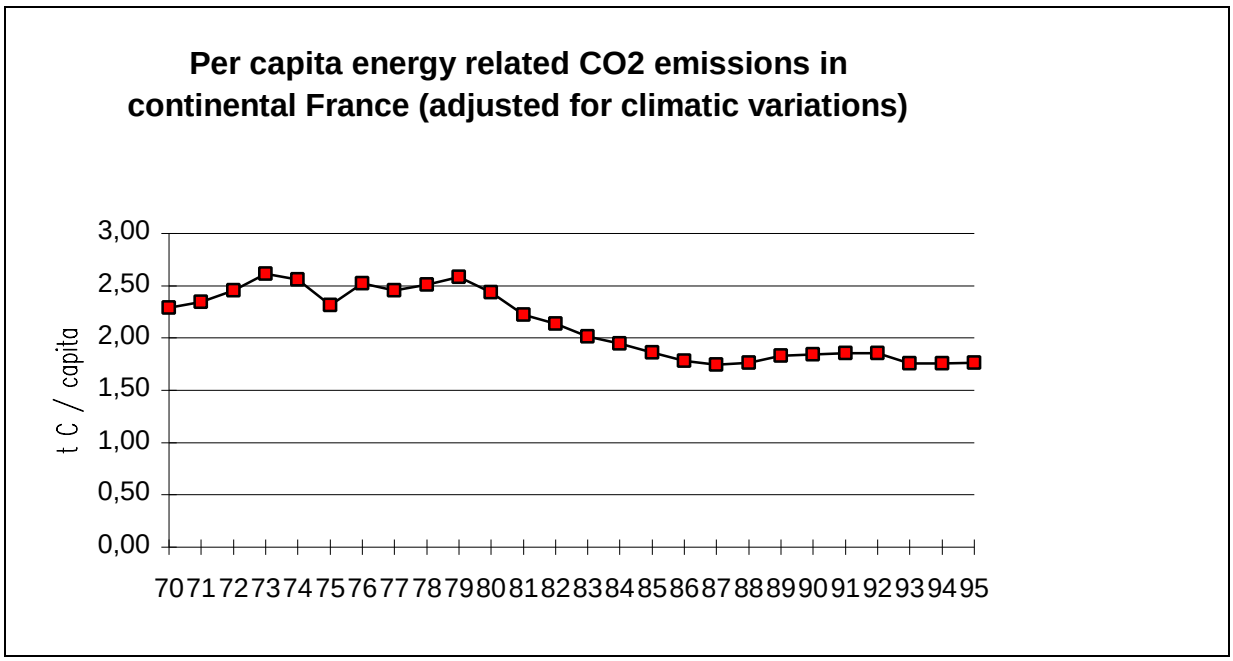
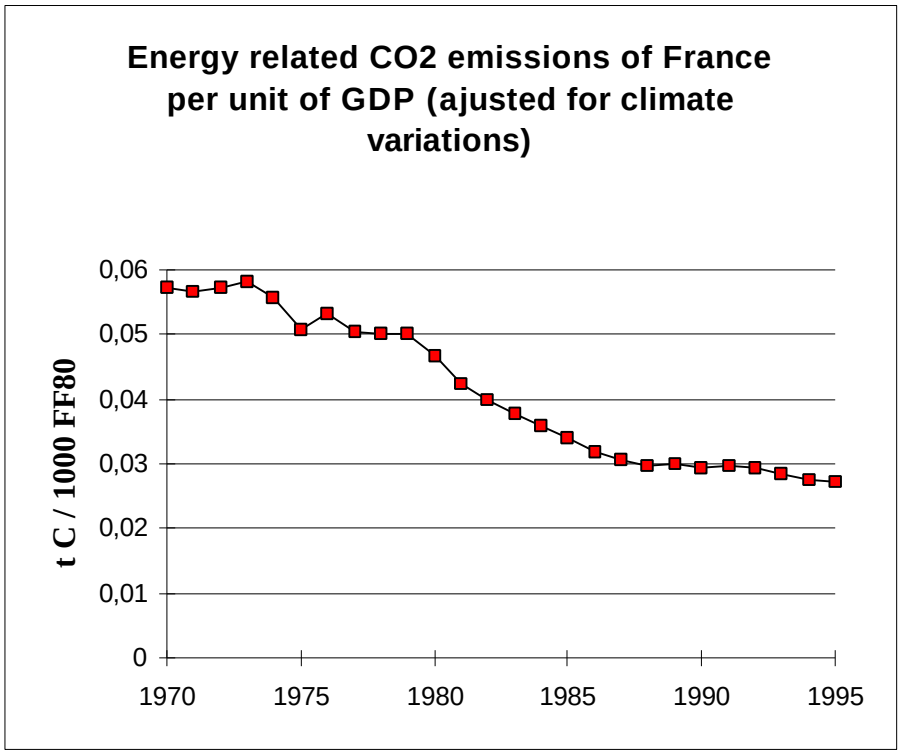


Figure 14



II. GREENHOUSE GAS INVENTORY

Introduction

This section highlights the main results of the greenhouse gas inventory for the 1990/1995 period. It covers the following gases:

- CO_2, CH_4 et N_2O direct greenhouse gases;
- NO_x, CO, COV indirect (precursor) greenhouse gases.

Following the recommendations of the UNFCCC, SO_2 emissions are also given. However, information on HFC, PFC et SF_6 are incomplete at this stage; they will be completed in the next inventories. A detailed inventory is included in an Appendix to this document.

In fact, France ended-up establishing two separate inventories, one concerning continental France the other the Overseas Districts and Territories ("DOM/TOM"), even though, "DOM/TOM" emissions currently represent less than 2% of total French emissions.

The estimates are presented here calculated according to IPCC recommendations issued in 1995. These are determined, initially, according to the CORINAIR system implemented at the European level and converted into the IPCC format using an *ad hoc* interface. Since 1994, date of the first inventory, several new elements (improvements in some available data, methodological changes, ...) have occurred that required revising the estimates established at the time (for additional details, see the "CITEPA" [Interprofessional Technical Center for the Study of Atmospheric Pollution] report). *Therefore new estimates presented here void and replace all previous estimates.*

The following table presents the aggregate emissions of all greenhouse gases for 1990 and 1995:

Table summary of
greenhouse gas emission in France

	1990 Emissions (MMT)	1995 Emissions (MMT)	1990/95 Evolution (%)
CO_2			
Emissions for all sectors	378	385	1.8
Energy use	357	364	2
Other emissions	21	21	0
CO_2 - Land use changes and forestry	-33	-47	42
CO_2 - Total net emissions	345	338	-1.9
(International bunker fuels - for the record)	17.5	16.8	-4
CH_4	3.02	2.84	-5.7
N_2O	0.182	0.173	-4.5
CO2 + CH_4 + N_2O (MMT of carbon equivalent)	465	451	-3
NO_x	1.91	1.78	-6.9
VOCs	3.15	2.77	-12.2
CO	11.35	9.47	-16.6
SO_2	1.35	1.05	-22.3

(*) Global Warming Potential (GWP) over 100 years, according to IPCC 1995.

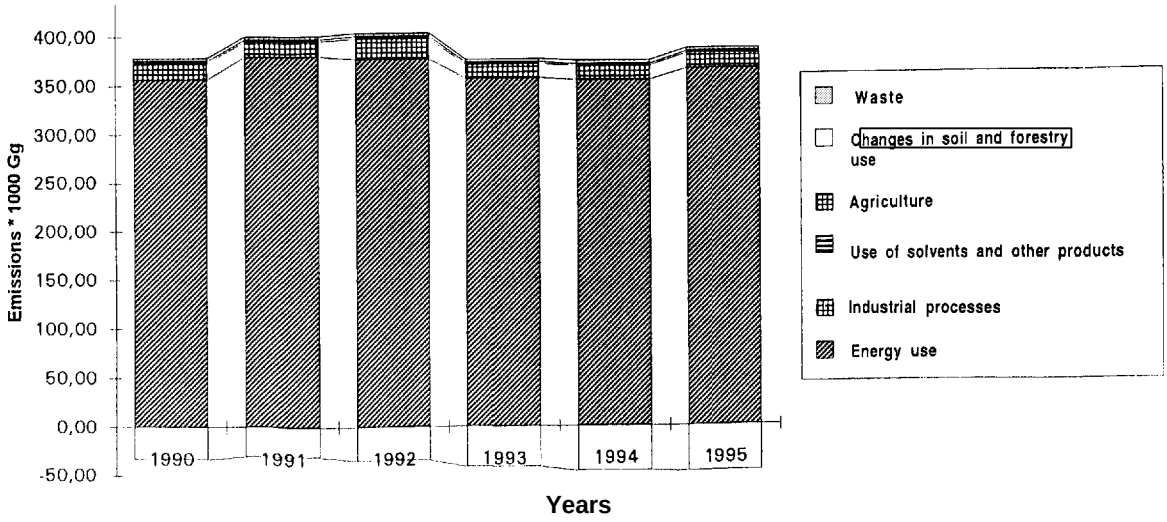
1. CO_2 emissions

Fossil fuel combustion is the highest source of CO_2 in France as in most industrialized countries. However, sectoral allocation is unique because of the energy sector's low share (production and processing) due to electricity generated by the large nuclear power sector.

CO_2 emissions due to fossil fuel combustion in 1990

Emitting sector	Gross emissions (MMT)	Ratio to total emissions
Energy (Production et Transformation)	82	23%
Industry	50	14%
Transportation	125	35%
Domestic / Commercial sectors	90	25%
Agriculture	10	3%
TOTAL	356	100%

Figure 15: Trend in CO_2 emissions (* 1000 Gg) from 1990 to 1995, for all of France (Continental + "DOM-TOM")



The trend in net CO_2 emissions over the 1990/1995 period, as illustrated by the above chart, can be explained as follows:

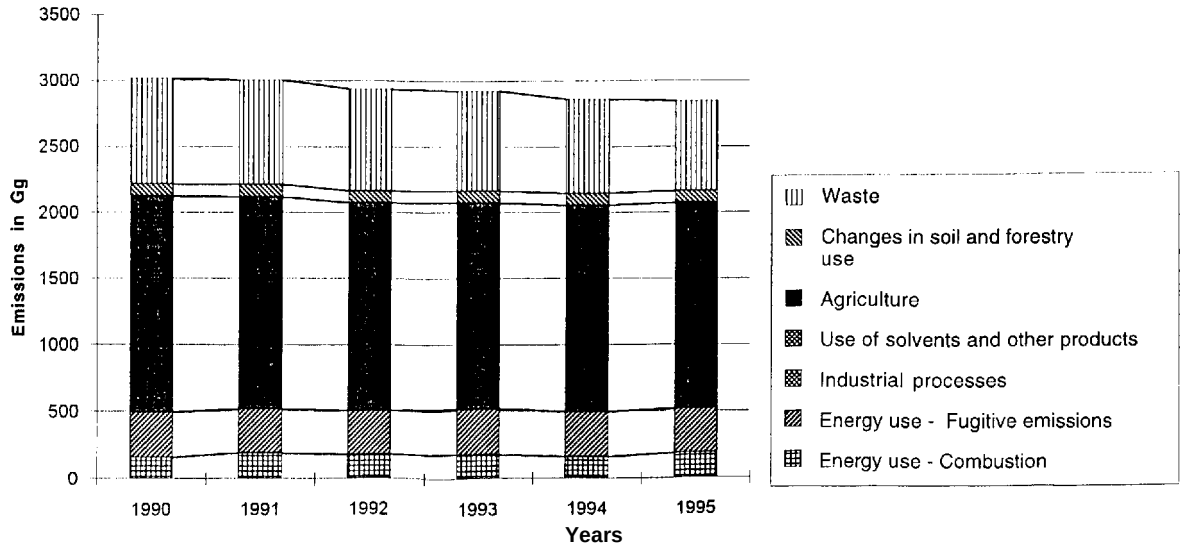
- a slowdown in economic activity, in particular the 1993 recession, led to a decrease in gross CO_2 emissions, linked, among other, to lower use of fossil energy that year;
- noticeably improved availability of the nuclear power plants since 1992 permitting, all things being equal, lower use of fossil-fuel power plants;
- a continued increase in the transportation sector following the long term trend even though its rate seems to be slowing slightly ;
- the relatively strong increase in emissions in French Overseas Departments and Territories (+25% between 1990/1995), even though these are still relatively low (around 3 MMTC/year in 1995).
- a high increase in forests sinks, due to the combined effect of increased annual biomass production and a drop in logging, 1990 was an unusually high year for timber harvesting.

Moreover, random factors should also be mentioned such a climate variation influencing heating requirements, as well as the supply of hydroelectric power .

2. Methane emissions

Data indicated for methane and nitrous oxide emissions are not very accurate, in particular because of uncertainties related to the assessment methods in agriculture and landfill emissions.

Figure 16: Trend in CH_4 emissions (in Gg) from 1990 to 1995, for all of France (Continental + "DOM-TOM")



Methane emissions amounted in 1990 to around **3 million de tons**, over 55% for agricultural activities, 25% from waste disposal activities, and especially landfill use, and over 15%, of fugitive emission from fuel extraction and distribution, remaining emissions are generated during fuel use. Methane emissions represent around 13% of direct greenhouse gases expressed in CO_2 equivalent for a GWP over 100 years (IPCC, 1995)

Methane emission trends over 1990/1995 are illustrated in the above chart.

Agriculture methane emissions were relatively stables over the 1990/1995 period, increased emissions related to animal waste handling was compensated by a drop in enteric fermentation.

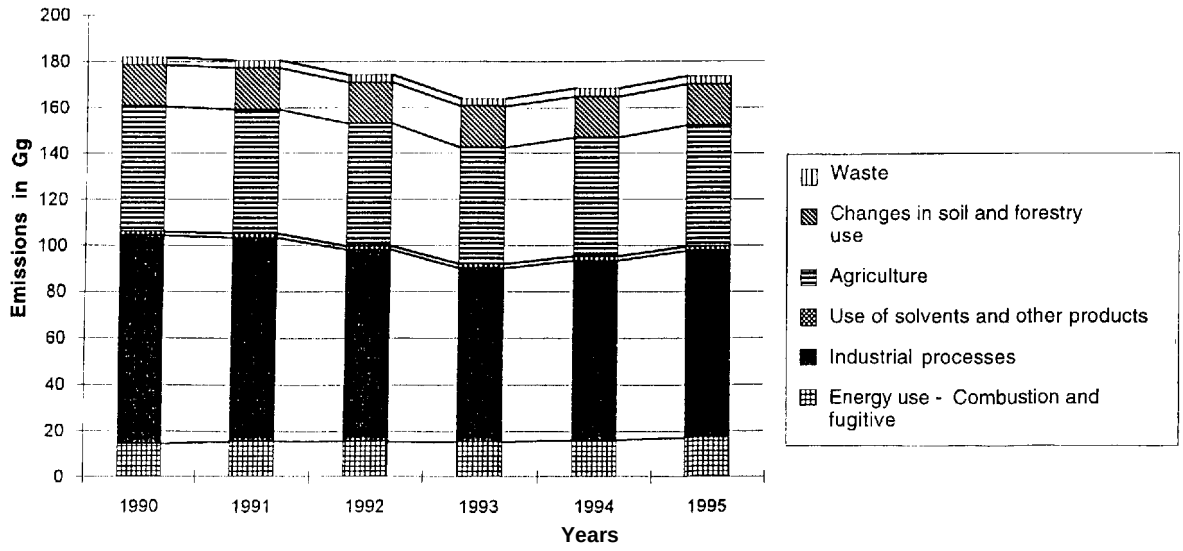
Since 1970, France has substantially reduced its emissions from coal production and gas distribution, because of the many mine closing since the early 70s and improvements in the gas distribution network.

By contrast, the increase in decaying waste in landfills contributed during the 80s to a sizable increase in methane emissions in this sector. The effect of the policy of closing landfills decided in 1992 has not yet been felt and emissions have continued to increase between 1990/95.

3. Nitrous oxide emissions

N_2O emissions rose to about **180,000 tons** in 1990, including 50% from industrial processes and 30% agricultural fertilizer use.

Figure 17: Trend in N_2O emissions (in Gg) from 1990 to 1995, for all of France (Continental + "DOM-TOM")



As for methane, time-trend data is limited for this pollutant. Industrial sector emission have been relatively stable, due mainly to the stability of the relevant activities, except for the production of nitric acid, where the drop in production was compensated overall by higher releases caused by denitrification facilities.

Emission trends between 1990/1995 changed little, as the above chart shows. A decrease in N_2O emission in agriculture should be noted, linked to a drop in fertilizer spreading, in particular in the arable crop sector.

4. HFCs, PFCs and SF_6 emissions

HFCs and PFCs are substitutes of HCFCs and CFCs. In 1997 an inventory of emissions of these greenhouse gases enabling an accurate determination of the quantities released in France will be carried out.

Indications can be inferred from the French annual consumption of products containing these substances (figures based on French consumption taken from European statistics on manufacturers):

- **HFC 134 - A** : 416 tons from aerosols, 166 tons from foams, 1,250 tons from refrigeration and air-conditioning;
- **HFC 143 - A et 125** (commercial refrigeration) :165 tons ;
- **HFC 23** (extinguishing agents) : 4.1 tons.

This consumption equals a *potential* in annual emissions of 0.81 MMTCE. The inventory underway will give more indications on actual emissions.

Indications can also be furnished on PFCs emitted in aluminum production, through anodizing : **CF_4**. Emissions of this gas were estimated by PECHINEY at 308 tons in 1990, i.e., around 1,570,800 MMTCE. It a voluntary commitment to reduce emissions of greenhouse gases of May 13, 1996, PECHINEY planned, for the year 2000 to reduce its emissions of CF_4 to 115 tons per year, i.e., 586,500 MMTCE.

SF_6 is an insulating gas used mainly in electric power motors (transportation, distribution) in particular in transformers.

According to information given by the International Union of Producers and Distributors of Electricity, "EDF" managed facilities for the transportation and distribution of electricity contain the following quantities:

- 183 tons of SF_6 for distribution facilities,
- 505 tons for transportation.

The volume of SF_6 purchased annually to replace the amounts of gas lost in transportation and electric distribution equals 5.9 tons, corresponding to a likely emission of 0.04 MMTs fossil carbon equivalent.

5. Indirect greenhouse gases: tropospheric ozone precursors

Emissions of nitrogen oxides, carbon monoxide and volatile organic compounds, have decreased noticeably in comparison with 1990 (see previous table).

For these three gases, during the relevant period, decreased emissions were observed in the road transportation sector, due to the application of European directives, and the increasing number of gasoline vehicles equipped with catalytic converters. The decrease was 7% for NO_x, 27% for CO and 19% for VOCs. The transportation sector represented in 1995, around 60% of NO_x, and CO emissions and around 40% of VOC emissions.

For **nitrogen oxides,** emissions are increasing in the commercial, institutional and residential sectors (+9%), decreasing in the electricity and heat generating sectors (-18%) and in industry (-10%, emissions linked to energy use in industry and industrial processes).

Major **carbon monoxide** emissions are generated, in addition to the transportation sector by the residential sector (1,7 million tons in 1995 linked to fuelwood and biomass combustion) as well as industry (1.1 billion tons from iron and still industry as well as the use of some types of coal). Waste incineration releases 0.23 million tons of CO.

Among the major sources of emissions of **volatile organic compounds,** mention should be made of solvent use: emissions equaled around 0.6 million tons in 1995 and decreased by 22% since 1990. VOC emissions from combustion equal 1.5 million tons (including 1 million for transportation) and have decreased by 13% since 1990.

6. Sulfur dioxide (SO_2)

SO_2 emissions were estimated at 1 million tons in 1995 in continental France and have decreased by 22% since 1990. This downward trend is true in particular for sulfur dioxide emissions linked to energy use, only waste incineration has increased its emissions of SO_2 during the period. This overall reduction in SO_2 emissions is part of a downward trend observed over the past dozen years in France (60% between 1980 and 1990). The trend should persist pursuant to the application of the commitments of the Oslo Protocol of June 14, 1994, a reduction in emissions reaching 0.87 million tons is planned for the year 2000, at 0.77 million tons in 2005 and at 0.74 million tons for 2010.

III. DESCRIPTION OF POLICIES AND MEASURES MITIGATING GREENHOUSE GAS EMISSIONS

1. CO_2 emissions (sources and sinks)

The measures described hereinafter concern, on one hand emissions linked to the use of fossil fuels and on the other hand the management of carbon sinks linked to biomass and soil organic matter.

The law No. 96-1236 of December 30, 1996 on the air and the rational use of energy stresses the importance given to combating climate change in France, in particular by including anthropogenic greenhouse gas emissions among atmospheric pollutants that must be controlled through the measures contained in the law (Article 2).

For example, various measures can be mentioned concerning rational energy use that permit a heightening of the efforts undertaken in this field (Title II) as well as a number of provisions concerning transportation (urban travel plans, tax incentives for less polluting vehicles), and provisions specifically targeting carbon dyoxide in particular in the traffic code (Article L. 8A of the Traffic Code: manufacture, maintenance and repair of motor vehicles).

1.1. Buildings

Considering the structure of the electric energy production sector (see Section 5), heating in buildings is responsible for nearly all CO_2 emissions (direct and indirect) in the building sector. Moreover, electricity represents a large proportion of the energy used for heating (around 30% of the energy consumed in 1995), and for which, because of an overequipment in nuclear facilities, the content in fossil CO_2 is low today and will remain so until at least the middle of the next decade.

France has been conducting a strong energy control policy in this sector since the first oil crisis based on regulatory measures targeted at new buildings and incentives for existing buildings.

1.1.1. New buildings

As early as 1974 France took the initiative in close cooperation with the construction industry, of mandatory heat insulation requirements for new constructions. The regulations were strengthened on a regular basis, and in the housing area, their scope was widened seeking a holistic approach to the building taking into account both heating performances of the building and of the heating equipment and hot water system.

The adoption of these regulations enabled reducing by half average specific consumption for housing built after 1975. Today, it is estimated that around 15% of total

heating consumption in the residential sector has been saved as a result of the implementation of these thermal housing regulations.

The long term impact on energy demand of the decisions made today in new construction, linked to the long life-time of buildings, incited France to enact even stricter regulations by anticipating constraints that will be implemented to mitigate the greenhouse effect.

1.1.1.1. New residential buildings

The requirements of current thermal regulation have been in force since Jan. 1, 1989. These were developed in 1985 seeking to minimize the overall adjusted costs linked to energy (higher investment costs decrease energy use and therefore lower operating costs).

In order to incorporate into the regulations advances made in the development of low-emissivity glazing, technical solutions offered to professionals have been changed. Strengthening of thermal regulations aimed at making them more stringent to a level equal to the energy saved by the substitution of low-emissivity double glazing to standard double glazing, initially scheduled for Jan. 1, 1997, was postponed until Jan. 1, 1999. A savings of 5 to 10% in heating needs in new housing units is to be anticipated from these measures.

Anticipated effects

Taking into account an annual construction rate of 270,000 new housing units and average heating consumption per housing unit, with current regulations, of 0.7 toe [tons oil equivalent] per year, a savings of 7.5% (on average) on new housing unit heating needs would result in a savings of 16,000 toe per year for buildings entering into service each year from 1999 on. It should be noted that the effect of stricter requirements in the regulations is cumulative; their impact on the long term is therefore much higher than their short-term impact.

1.1.1.2. New commercial sector

Current thermal regulations in force in the new commercial sector (buildings other than housing) are less stringent than those applying to new housing units since Jan. 1, 1989. These regulations are being revised, with the aim of gaining 25% energy efficiency, but this is a heavy task considering the extremely varied operating conditions and different uses of units in the commercial sector.

In order to encourage professionals right now to design more energy-efficient buildings than what current regulations require, sectoral guides have been written by "ADEME" and the Association of Air-conditioning, Ventilation and Cold Engineers. Publication of these eight guides (hotel, office, health, educational, retail, leisure, industry and agricultural sectors) took place between 1992 and 1997.

Taking into account required dialogue with the professional organizations, the entry into force of the new regulations was postponed. For non air-conditioned buildings (77% of new projects today), the new regulations will be issued before June 6, 1998 and apply as of April 1, 1999. Regulations for air-conditioned buildings will be issued before June 1, 1999 and apply as of June 1, 2000.

Anticipated effects

If construction of offices remain at their current level, it is estimated that a unit energy saving of 25% compared with regulations in force, will result in an energy saving of 60,000 toe per year for buildings entering into service each year as of 1999. As with new housing units, this measure will have a cumulative effect over time.

1.1.2. User information

The law on air and rational energy use of Dec. 30, 1996 required that a standardized estimate be supplied regarding annual energy costs of housing units or commercial units for sale or lease. A decree should specify the rules on computing the estimate. At this stage it is not possible to assess the impact of this measures with respect to CO_2 emissions, it concerns both new and existing buildings.

1.1.3. Existing buildings

There are 27 million housings in the residential sector, including 22 million principal residences occupied on a permanent basis, and 720 millions m^2 of heated commercial premises. Most of this property, 75% for housing and around 65% in the commercial sector, was built before the entry into force of the first thermal building regulations in 1975.

Beginning with the first oil crisis, France developed a strong energy control policy for existing buildings and major improvements have been made. Three types of actions were launched.

- decision making assistance aimed at encouraging owners to carry out energy saving improvements,
- regulation and standardization of components,
- investment aids, subject to several terms and conditions such as direct subsidies or tax incentives.

It is estimated that investments in energy savings in housing built before 1975 carried out pursuant to these measures have permitted energy savings for heating of around 10% of total heating consumption. However, there still are profitable interventions to be made in energy savings, and control of energy consumption and CO_2 emissions in the existing building sector will be pursued in the three directions mentioned above.

1.1.3.1. Encouragement for energy-saving improvements

Various financial incentive provisions for improving existing housing will be mobilized in order to focus on projects that are the most efficient with respect to combating the greenhouse effect. The percentage of this public financing spent on energy savings can be assessed at 2.5 billion French francs in 1992. The provisions are as follows:

- Tax credits: income-tax credits were available from Jan. 1, 1990 to Dec. 31, 1995 for heat insulation improvements, heating regulation, replacements of boilers or in some instances for installing an insert for principal residences built before Jan. 1, 1982. This measure was renewed in 1996.

- Subsidies for housing improvements: this State subsidy is to help low-income homeowners improve their housing units that are over 20 years old, which are principal residences.

- Subsidy from the National Housing Improvement Agency ("ANAH"): this subsidy is aimed at helping improve rented housing units by private owners, built over 15 years ago.

- Subsidy for rental and social housing improvement ("PALULOS"): this subsidy is to assist organizations to improve their rental housing units that they own or manage for social welfare purposes and that are over 15 years old, for the purpose of housing for low-income people.

1.1.3.2. State buildings

State buildings consume each year 2.25 million toe and spend 3 billion French francs per year on energy.

The Prime Minister asked in a circular of January 24, 1991 that each Ministry implement an energy-saving program in buildings under its authority. These actions are coordinated at the national level by a group of senior civil servants responsible for energy within each Ministry.

The current goal is to implement on a priority basis, as of 1995, investments for which the payback will be under 6 years so that state buildings serve as a reference in the energy field, applied to new buildings as well as renovations and the operations of existing buildings. This action represents a priority of "ADEME" which spent 3.2 billion French francs in 1996 on this.

Energy consumption in existing state buildings could thus be reduced by around 12% i.e., a reduction of 200,000 tons of carbon emissions per year in the year 2000.

1.1.3.3. Fuel taxation in the residential/commercial sectors under the greenhouse effect.

Under the fiscal approach to combating the greenhouse effect, France has proposed to its European Union Partners establishing a tax on fuels used in the residential and commercial sectors.

The current minimum excise tax on domestic heating oil should be gradually increased and a minimum excise tax be established on natural gas, liquefied petroleum gas and coal for residential and commercial use. The excise tax should also apply to fuels used for generating electricity for residential and commercial uses.

Anticipated effects of all the measures concerning existing buildings

For housing units built before 1975, the "ADEME" estimated that energy savings that would be profitable, if the price of oil is at 20 dollars a barrel, and a possible tax of 70 ECUs per ton of carbon with an discount rate of 8%, should result in 5.5 million toe per year in the residential sector and probably 2.4 million toe per year in the non-residential sector. The cost of total investments for the implementation of these 5.5 + 2.4 million toe per year would come close to 150 billion French francs.

All of the measures mentioned in § 1.1.2. should help tap this reserve of energy savings potential. It should be noted that energy prices also play a crucial role in encouraging the implementation of these energy-saving investments.

1.1.4. Increasing the use of timber in construction

In 1990, French consumption of wood products in the form of panels and boards reached 14.7 million m3, i.e., around 0.27 m3 per capita, per year. Most of this timber came from French forests; in 1990 less than 10% of the timber was imported (most imported wood comes from logging in sustainably managed forests).

Out of 14.7 million m3, 12 million m3 is for permanent use (in furniture and construction), this represents a long term sequestration of around 2 MMTC per year, 80% in the construction sector and 20% in furniture. In 1995, French timber consumption in the form of lumber and panels dropped 7% compared with 1990.

Market research on French wood product consumption showed that there was a potential for large sales increases in construction; action in this field including the following three approaches was therefore launched in 1993:

1. Developing actions to promote wood products in construction This task was entrusted to the National Committee for Timber Promotion ("CNDB").

2. Lifting factors impeding a larger use of wood products in construction through research, development and *ad hoc* vulgarization; conducted by the Technical Center for Timber and Furniture ("CTBA").

3. developing a strategy of supplying products or partially industrialized wood products relying on the sawmill industry.

4. the implementation a permanent monitoring tool generating reliable market data and trends in wood product use in construction.

Measures implemented

A portion of public financing to fund the "example setting achievements" in the assisted rental housing sector is targeted to operations using wood materials in which timber is used to its best potential to meet the technical challenges of the sector (speed, quality, construction site set-up,...)

New actions regarding research on timber in construction have been launched between 1990 et 1994. This effort was increased with the implementation, in 1996, of a multiannual research program organizing research in this field.

In 1993, all these actions promoting the use of wood products as well as research, have been granted public funds amounting to 53 million French francs.

The regional state administrative departments have, moreover, been asked to ensure that timber is not penalized, in particular that:

- local zoning regulations do not contain unreasonable prohibitions on using wood on the outside of buildings,

- the specifications issued by the public owners in construction projects must consider all the technical options in a balanced way,

- timber must not be excluded because of its combustible properties as long as the provisions in the regulations on fire-resistance of the works are complied with.

Finally, within the scope of the law on air and rational energy use of Dec. 30, 1996, it was decided that a decree will determine the conditions under which certain new buildings must contain a minimum amount of wood products before Jan. 1, 2000.

Anticipated effects

Timber use in construction can only be significantly increased over the long term: this assumes, indeed, a radical change in consumer patterns, as well as a serious enough restructuring of the industry so that it manages to assert itself in a highly competitive market dominated by large industrial groups outside the timber construction sector.

Anticipated effect by 2010 of the policy described above follow what was mentioned in the First National Communication of France.

The policy should enable the sequestration of an additional 0.35 MMTC per year (25% linked to developing wood frames and 75% to decorations, fittings and carpentry), i.e., an increase of 17.5% compared with the 1990 level.

Moreover, the emission of an equal amount of fossil carbon can be avoided thanks to the reduction in consumption of materials (concrete, steel and PVCs) that consume a lot of fossil energy to produce.

1.2. Industry

Since 1973, France has been engaged in a process of reducing its energy consumption resulting in particular in a reduction in CO_2 emissions in industry of 38% between 1973 and 1990, whereas, during the same period, industry added-value increased by 24%.

Moreover, it should be noted that more than three quarters of industrial CO_2 emissions are caused by a few sectors for which energy is a major cost component: non-ferrous metals, iron and steel industry, building materials, refining, paper and cardboard, glass, agrofoods, chemical industry. These sectors are concentrated into around a thousand companies that represent 17% of industry's added-value. This justifies, considering the risks of delocalizations, that France wishes that actions concerning industry be harmonized within an appropriate geographic framework and that France intends to exempt fuels for industry from CO_2 taxation that would be applied at the Community level only.

1.2.1. Voluntary agreements

In order to shed light on actions to be undertaken, the "ADEME" has ordered studies aimed at offering an initial systematic technical-economic approach, by sector and by type of action, of the potential untapped fossil energy savings in industrial uses.

Thus, it explored an area of actions that represents up to 20% of potential CO_2 emission reductions through savings in fossil energy or by energy substitutions, i.e., about 5 MMTC on the basis of 1990 activity levels.

This untapped saving takes into account payback times that are higher than those applied today in industry, that are approximately 1 to 3 years, and its effective implementation assumes that all opportunities have been taken that will gradually open up by production platform renewals, with the adoption of new technologies for which technical-economic feasibility is not finally ensured in every instance.

This potential untapped saving is high, but can only be fully exploited if we know how to create the conditions, at the international level, enabling such exploitation without introducing competitive distortions: this difficult issue must be dealt with in the spirit of Article 4 of the Montreal Protocol on CFCs.

France, for its part, has undertaken in 1995, discussions with companies in high energy consuming sectors aimed at the signature of voluntary commitments on control of their greenhouse gas emissions. A this stage, voluntary agreements have been signed with six partners (branches or industries), on the basis of the following objectives:

	1990 Emissions MMTCE (GWP over 100 years)	2000 Emissions MMTCE (GWP over 100 years	1990/2000 Evolution (%)	Evolution in specific emissions (per unit of product) (%)
Pechiney group (aluminum)	0.78	0.515	-34	
* incl. CO_2	0.35	0.355	+2	-19
* incl. CF_4	0.43	0.16	-63	-73
Cement industry	1.8	1.35	-25	-10
Fat lime and magnesia lime manufacturers	0.24		-5 à 5	-5
French Steel Federation	7.1	6.4	-10	-15
Glass packaging industry	0.53	0.5 in 1999 0.47 in 2005	-5 from 1990/1999 -10 from 1990/2005	-18 from 1990/1999 -27 from 1990/2005
"3 Suisses France"	0.03		-5	-25

Negotiations are underway with the French Smelters' Union. In other branches (chemical, paper and agrofood industries) discussions have taken place, with no agreement in sight.

1.2.2. Supporting measures

As early as 1974, France required carrying out regular energy audits in industrial plants consuming more than 300 toe/year by experts approved by the public authorities.

This provision, which anticipated recommendations of the SAVE directive, is currently being rewritten: the objective is to more effectively incite industries to seize the right opportunities to advance energy efficiency.

Assistance for energy savings in industry can be summarized today as follows:

a) Financial assistance from "ADEME"

- Support for Research and Development.

Projects that receive assistance involve mostly industrial processes (iron and steel industry, smelting, non-ferrous metals, chemical and paper industries), generic technologies (heat exchangers, radiant energy, drying, crushing, heat pumps). Furthermore, the "ADEME" grants a dozen research scholarships (PhDs) a year on these subjects.

- Decision-making assistance, in particular subsidies for referrals to outside consultants, for measuring energy use, or sectoral actions.

- Assistance for demonstrations of exemplary investments

From 1990 to 1993 the sum of these interventions reached 398 million French francs including 132 MFF for R & D and 45 MFF from the regions.

Moreover, under the Goal-Targeted Contract signed in 1995 between the state and the "ADEME", measures for collective assistance to decision-making through public calls for suggestions will be implemented. Finally, completing "ADEME's" actions in this field, individual regional assistance for Small and Medium-Size Industries will soon be established through making available the Regional Funds for Consulting Assistance to energy control issues.

b) Tax incentives

- Extraordinary depreciation, over twelve months as of entry into service, of various equipment used for energy savings or to generate electricity through cogeneration.

- An abatement of 50% or 100% in the tax-base of the business tax or the property tax on constructed property, or on equipment having been depreciated on an extraordinary basis as mentioned above.

- Excise tax exemptions on gas and heavy oil used in cogeneration.

- The Companies Approved for Financing Energy Savings ("SOFERGIE") are granted, in certain instances, a tax exemption on profits and capital gains made on the leasing or rental of equipment used to save energy.

These tax incentives are currently being reviewed within the framework of the mechanism assessing energy control policies; whether they are maintained or modified will be decided at the end of the current financial year, during 1997.

1.3. Transportation

1.3.1. Freight transportation (excluding light trucks)

In the past, technical advances made on vehicle design and an increase in their average size slowed the growth in emissions caused by an increase in traffic; it is estimated that average consumption of heavy trucks has dropped from 34.7 l/100km in 1985 to 33.6 l/100km in 1995, i.e., an average annual drop of 0.3%. Without corrective measures, CO_2 emissions for freight transportation would have continued to grow at a steady rate. France has undertaken three types of actions in this sector:

- technical measures for vehicles in order to reduce specific fuel consumption of heavy trucks;

- institutional actions on the organization of freight road transportation, compliance with social regulations, and pricing;
- an attempt to stabilize modal shares, thanks on the one hand to the development of intermodal transportation with a special focus on combined road-rail transportation and on the other hand an improvement in the network of waterways.

It should be noted that these actions are within the scope, to a large extent, of initiatives to be taken at the European Union level.

1.3.1.1. Technical provisions concerning heavy trucks

The fleet of French heavy trucks includes both older vehicles that travel short distances (30,000 km per year), and newer vehicles with increasingly powerful engines and covering a large number of kilometers (100,000 km per year). Age and increased power are both factors that increase consumption.

Enough power is needed for the vehicle to enter the flow of road traffic and contributes to safety and traffic fluidity. However, even if the average energy consumption (ratio of overall consumption measured over the total number of kilometers covered) of heavy trucks has dropped by close to 20% since 1970, some engine configurations today seem excessive. The advisability of setting limits on the power to weight ratio of these vehicles should be examined at the Community level.

Furthermore, as mentioned in § 1.3.2.1.2 on safety inspections of vehicles in service a decree of July 5, 1994 extended as of January 1, 1996, the requirement to repair vehicles subject to a technical safety inspection (such as heavy trucks and buses) if they fail pollutant emission tests.

1.3.1.2. Institutional actions

In order to restore better working conditions in the profession, various measures were decided in December 1993, in agreement with professionals in the trucking industry:

- making access to the profession more stringent,

- France is acting to promote at the Community level the requirement of tamper-proof chronological speedometers,

- Increasing penalties in the event driving-time and rest regulations are breached.

These measures were implemented as planned. The end of restrictions on cabotage within the European Union planned for July 1, 1998 should include harmonization of working conditions in the sector in the various Member States. The end of these competitive distortions was requested by France in a memorandum remitted in 1989 to amend regulations on driving time into regulations concerning the number of driver working hours.

Likewise the current minimum excise taxes on fuels, determined at the EU level, must be gradually raised to cover the costs of climate change and, more generally, those related to the external effects of transportation.

Several EU countries, including France, have made a serious effort to raise their excise taxes: in France, the excise tax on diesel is 45% higher than the minimum Community rate following increases after 1990. Minimum European Union rates must be increased so as not to create competitive distortions in road transportation or delocalizations in fuel purchases. Furthermore, these increases must be announced well ahead to time in order for companies to adjust to the change in rates in the medium and long-term.

1.3.1.3. Development of intermodal freight transportation

The objective is to develop intermodal alternative to road transportation, where these are relevant and in particular with:

- combined road-rail transportation (containers and mobile containers) for long-distance shipments,

- rail freeways (shuttles) for heavily traveled routes or the passage of geographic obstacles (crossing the Alps for example).

Road-rail combined transportation, in spite of efforts made by the European states and railroad companies, still represents a small proportion of traffic. In France, road-rail combined transportation (12.2 billion tons/km in 1996) increased by 41% between 1991 and 1995 and by 20% between 1995 and 1996. Today it equals, in tons/km, 13% of traffic beyond 500 km.

France is a transit country and transit freight traffic is expected to continue increasing at an annual rate of nearly 4.5% and will correspond to over one quarter of the increase in land-based freight traffic for all modes in France between 1990 and 2000. Whereas it is with long-distance traffic, and in particular international traffic that combined road-rail transportation can be competitive, the situation in the various European Union countries shows the limits of national policies that are being implemented: in the case of countries on the edge of the Union, it should be noted that 92% of land-based freight in Spain and Portugal traveling to other Member States and 83% in Italy and Greece, is hauled by road.

The objective by the year 2000, in the field of combined transportation, is to double the volume compared with 1990 (+7 G tons/km). In particular, efforts made for expanding infrastructures are aimed at making sure that the development of combined transportation is not hindered by a lack of capacity.

Institutional aspects

In order to foster combined road-rail transportation in international traffic, Community directive 91/440/EEC have provided for enabling access to rail infrastructures of the Member States to international combined transportation. France incorporated into its domestic law the directive. The law of February 13, 1997 that established the public corporations "*Réseau ferré de France*" (the French railroad network), responsible for

development and enhancing the value of the rail infrastructure, is a crucial stage for implementing the directive.

From a technical standpoint, true inter-operability of Community rail networks must be guaranteed. France wishes that the European Union avail itself of the means to coordinate regulations, technical specifications and standards concerning current features of the infrastructures, rolling-stock and logistical means.

Research and development

Substantial funding for research and development was devoted to intermodal transportation within the scope of "PREDIT" (Program for research and development for innovation and technology in road transportation) over the 1990-1994 period. In 1995 a decision was made to launch a new PREDIT program for 1996-2000 period with funding of around 400 MFF for intermodal freight transportation.

Infrastructure development

Upgrading to gauge B+ of major freight lines is being pursued. Financing since 1985 of the gauge upgrade has reached 250 million French francs; an additional 700 million French francs will provided by 2000.

New transfer platforms will be built between 1994 and 2000 on four of the ten major focal points of combined transportation in France (Bordeaux, Lille, Lyon and Marseilles). State and regional contributions to these investments will equal 100 million French francs per year, which represents more than three times the amount compared with the 1989-1993 period (30 million French francs per year). This effort will be completed by equipping the "Paris Nord Est" train station construction site and by upgrading other terminals that form a part of this network.

Regarding rail freeways, the recent opening of the Eurotunnel shows that technologies are now available. Preliminary studies for the high-speed Lyon-Turin line that are about to begin also cover freight traffic. The opening of a rail freeway between Ambérieu and Turin and, initially, a shuttle service through the French-Italian tunnel will be studied.

Regarding the development of the waterways network, projects underway (Niffer-Mulhouse, dredging of the Saône, Bray-Nogent) will enable maintaining some traffic that would otherwise have shifted to the road.

Assistance with equipping trucking companies

Pursuant to Community regulation 1107/70/EEC as amended, the state, the "ADEME" and "EDF" implemented in 1990 a program to encourage trucking companies to purchase combinable equipment. The mechanism is aimed at fostering access for small and medium-size companies to combined road-rail transportation: trucking companies that wish to access combined road-rail transportation or increase their freight volume using this method, may received financing for required equipment (road-rail semi-trailers, mobile road-rail containers that can be attached to their underframes, bimodal units) through leasing at low rates in exchange for meeting combined road-rail transportation targets. A system of penalties in the form for higher rents in the event of failure to meet the targets is implemented.

The process will be pursued by allocating the required funding to meet the demand of the trucking companies. The total amount of assistance recorded since 1990 reached, at the end of 1996, 17 million French francs, for a total investment of 102 million French francs.

Anticipated effects

Actions undertaken at the French level, regarding freight transportation, will only be effective if they are relayed at the Community level by a more balanced policy of allocating transportation costs (infrastructure, congestion, safety and environmental costs) and by better respect for social regulations and by stronger investment assistance.

Under these conditions, and provided this action-oriented policy is pursued beyond the year 2000, over the 2000/2020 period, the impact of all the measures concerning freight transportation would increase from 0.35 MMTC/year in 2000 to 1.6 MMTC/year in 2020.

1.3.2. Passenger transportation and light trucks

Passenger car CO_2 emissions have risen at an annual rate of 1.6% between 1990 and 1995 and that of lights trucks rose by 2.9%. These growth rates are lower than traffic (expressed in vehicle/km): 2.5% and 3% respectively. These figures reflect a drop in average consumption of the fleet caused in part by the drop in consumption of new vehicles designed before the oil crisis of 1985.

Following a long period of decreased consumption, begun with the first oil crisis and which persisted until the end of the 80s, standard average consumption for new vehicles, gasoline or diesel, sold in France, is moving up again. This increase is especially strong in urban consumption, linked with an increase of 10% in the average weight and engine power of the vehicles over the 1985-1993 period. It should be noted that vehicles remain geared for intercity use on freeways whereas over 50% of energy consumed by road transportation is in the urban environment and that, over the last fifteen years, energy consumption of urban transportation has risen four times as fast as in intercity transportation.

Measures that France intends to take and that will have a significant impact on CO_2 emissions of passenger transportation are of several types:

- with technical improvements to passenger vehicles and light trucks, reducing specific vehicle consumption and inciting buyers to choose high mileage vehicles, to foster the development of vehicles designed specifically for cities and to promote alternative vehicles.

- with urban travel, local authorities should encourage the promotion of better organized travel within the city.

- with inter-regional travel, developing transportation options, high speed trains, replacing fossil fuels with electric energy.

1.3.2.1. Technical improvement to vehicles

1.3.2.1.1. Reduction in specific consumption of new vehicles

Measures to be taken in this field must be coordinated at the European Union level. France fully supports the Conclusions of the Council of June 25, 1996, announcing the objective of an average level of CO_2 emissions for new cars sold in the European Union of 120 g CO_2 per km to be reached by 2005 or, at the latest in 2010.

Pursuant to the conclusion of the Council, this objective must be reached within the scope of voluntary agreements with the automobile industry. This is the context in which French automobile manufacturers, Renault and PSA Peugeot Citroën, have voluntarily undertaken to lower CO_2 emissions of new vehicles sold within the European Union to less than 150 g CO_2/km in 2005.

Furthermore, the new PREDIT program will maintain its research effort on the consumption of new vehicles over the 1996-2000 period. Around 2 billion French francs in programs will be spent for energy-saving vehicles. Improvement in the fuel-engine-depolluting cycle, research on materials and the lighter vehicles, focus on non-conventional engines, designing low consumption demo projects are the main actions being considered on this issue.

Anticipated effects

Assuming that the objective of 120 g CO_2 /km will be reached in France in 2010 and the consumption of light trucks follows the same trend a reduction in emissions of around 4.7 MMTC/year can be obtained by 2020.

1.3.2.1.2. Safety checks for circulating vehicles

Out of an estimated 24 million French passenger cars (private and commercial), 62.5% are estimated to be over 4 years old.

Safety inspections have been mandatory since December 31, 1985, upon the sale of a vehicle over 5 years old and under 3.5 tons. A regular safety inspection has been required for all these vehicles, whether sold or not, as of January 1, 1992. The inspection carried out in approved centers, covers 52 items defined in a decree of June 18, 1991 among others inspection of carbon monoxide emissions (gasoline) and exhaust fumes (diesel).

The safety inspection has been required every two years for vehicles that are over 4 years old since January 1, 1995. A decree of July 5, 1994 requires mandatory repairs of vehicles that have failed pollutant emission tests during the safety inspection, as of:

- October 1, 1994 for gasoline vehicles without catalytic converters,
- January 1, 1996 for diesel vehicles,
- January 1, 1997 for gasoline vehicles with catalytic converters.

Anticipated effects

Safety inspections seem to have had a positive impact on the tuning of gasoline vehicles since the failure rate observed was higher than 50% during free inspection drives sponsored by the "ADEME" in the early 90s, and is now only 25% with current mandatory inspections.

An average drop of 10% in consumption and in pollutant emissions on 50% for gasoline vehicles that were not in conformity in 1990 can be anticipated.

1.3.2.1.3. Bonus for the destruction of vehicles that are over ten years old

A 5,000 FF bonus for replacing with a new vehicle one that is older than 10 years old and must be destroyed, was implemented in early February 1994 until the end of June 1995. From October 1, 1995 until September 30, 1996 an "automobile quality bonus" was substituted replacing vehicles that were over 8 years old.

Compared with natural renewal, it is estimated that these bonuses have encouraged replacement of close to one million additional old vehicles while these bonuses were in force. Impact on CO_2 emissions is large in the short term (several thousand tons of carbon a year).

1.3.2.1.4. Developing vehicles specifically designed for urban areas

Urban traffic represents an increasingly large share of vehicles in circulation though vehicles are designed for traveling at 130 km/h on freeways; a third of the 14,000 km annual average distance covered by a light vehicle is in an urban environment, the equivalent of half the fuel consumption.

Increased fluidity as well as less pollutant emissions must be sought thanks to a vehicle especially designed for urban use, featuring a small size, lower power, speed and lower pollutant emissions, less noise and a corresponding decrease in passive safety requirements currently determined by the traveling speed on roads and freeways. For the purpose of defining specifications for such a vehicle, the French government has set-up a working group involving all the relevant actors.

This group is reviewing regulatory measures needed at the Community level, tax measures at the national level and measures concerning traffic regulations at the level of urban areas which could foster a new market large enough to make the price of such an « urban » vehicle competitive. Its conclusions should be available in 1998.

Anticipated effects

In France, the annual market for new passenger cars is around 2 million vehicles. It is not yet possible to determine market volume for this specifically urban vehicle knowing that manufacturers will only design this type of product if the conditions are met to ensure that its sales expand rapidly.

At best, an objective of around 1% of the market could be set for a specifically urban vehicle by 2000. This objective will only be met if an action-oriented policy is conducted simultaneously in all the Member States of the Community, thus contributing to creating a real community-wide market for a specifically urban vehicle.

1.3.2.1.5. Promoting electric vehicles and other alternative vehicles

The law on air and rational energy use of Dec. 30, 96 enacted a number of measures aimed at fostering the development of electric vehicles and other alternative vehicles powered by liquefied petroleum gas or natural gas. Besides extending exceptional depreciation benefiting electrical vehicles to other alternative vehicles, to specific equipment and electric motor scooters, the main measures are the exemption or decrease in the tax on company vehicles for electric vehicles or other alternative vehicles as well as the requirement that the various public managers of vehicular fleets procure a minimum of 20% of such vehicles when renewing fleets;

These measures complete existing measures, aimed at encouraging the purchase of electric vehicles (5,000 FF bonus from the state in effect until Dec. 31, 1998 limited to 10,000 vehicles) or use of other alternative vehicles (drop in the excise tax on LPG fuel). These measures support research on these types of vehicles.

Anticipated effects

The French electric vehicle fleet remains marginal, near 3,000 vehicles.

The targeted objective is that electric vehicles be purchased by the general public, which in spite of efforts made by the two major French manufacturers in coordination with the public authorities and other partners, is still fledging. A real growth in electric vehicles and other alternative vehicles will have to wait several years and can be anticipated around the year 2000: replacing standard fossil fuel vehicles by 100,000 electric, 300,000 LPG and 3000 natural gas vehicles would allow for a savings of several thousand tons of carbon at least. Beyond 2000, a real increase in the number of electric vehicles may be witnessed if the initial large-scale marketing of the vehicles enables, we hope, manufacturers to overcome economic hurdles that, in the current phase, still prevent the general public from adopting electric vehicles.

1.3.2.2. Urban travel

The law on air and rational energy use of Dec. 30, 96 made it mandatory for all cities with populations of over 100,000 to draft urban travel plans. These urban travel plans, drafted and implemented by the competent authorities organizing urban travel in the relevant cities, define the principles of organization for public passenger transportation as well as for freight, traffic and parking.

The urban travel plans focus in particular on automobile traffic reduction, the development of less expensive and polluting transportation modes, the development and exploitation of networks of streets, organizing parking, transportation and freight delivery, etc.

Anticipated effects

It is difficult to calculate before hand the impact of the measures that will be enacted by the local authorities within the scope of urban travel plans. The impact should remain marginal in 2000, but could rise beyond 1MMTC/year by 2020.

1.3.2.3. Development of high-speed trains

Following the opening of the first TGV (High-speed train) line in 1981, France decided to build a high-speed rail network adopting as early as 1991 a master plan of national high speed rail links.

This plan provides for around 4,700 km of new high-speed lines of which 1,260 were already operational in 1995:

- TGV South-East between Paris and Valence
- TGV Atlantique
- TGV Northern-Europe and cross-channel link
- Ile de France (Paris region) interconnection

By 2000, the Mediterranean TGV will be completed up to Marseilles and the first phase of the Eastern TGV will have begun from Paris to the Moselle Valley.

Moreover, the state is encouraging research and development in particular through "PREDIT". 445 million French francs have been allocated specifically to high-speed trains between 1990 and 1994 with, in particular, the new generation TGV program. This effort will be pursued within the scope of the new "PREDIT": around 500 million French francs will be spent on the high-speed train system.

Expansion of the TGV network allows replacing fossil fuel generated power by non-fossil fuel generated electricity (nuclear or hydropower) for "high-speed" traffic (freeways, aircraft or trains). Its therefore has a positive impact on greenhouse gas emissions.

Infrastructure expenses for the high-speed network reached 33.3 billion French francs from 1990 to 1995, i.e., 5.5 billion per year. The cost of the future Mediterranean TGV and Eastern TGV is estimated at 48 billion French francs.

Anticipated effects

Traffic estimates by the "SNCF" (the French National Rail Company) concluded that the opening of the Mediterranean and Eastern TGV will divert from air travel respectively 1.8 and 0.7 billion passenger/km per year. Diversion from road travel would reach 0.7 and 0.3 billion passengers/km per year.

It is estimated that this will lead in 2000 to substituting electric energy that is « climate friendly » by 130,000 toe per year for aircraft and 30,000 toe for road travel. The estimated gain in terms of CO_2 emissions will therefore be around 130,000 tons of carbon per year.

1.4. Electricity

France's originality in terms of electric production considerably narrows its options for mitigating future emissions in this sector.

Nuclear power, implemented in France more than in any other country, eliminates all CO_2 emissions. CO_2 offset by French nuclear production of 378 TWh can be estimated in 1996 at 117 MMTC if compared to coal power plants and 59 MMTC if compared to combined-cycle gas power plants.

Fossil fuel power production by "EDF" dropped from 30.4 TWh in 1993 to 12.6 TWh in 1994, then rose again to 17.4 TWh in 1995 and to 21.2 TWh in 1996. The 1995 rise was due mostly to regulatory requirements on the maximum temperature of nuclear plant water discharges, that required stopping some plants during the summer of 1995. In 1996, the new increase can be explained by the drop in hydropower production which already occurred in 1995 and an increase in demand in France.

Fossil fuel power production excluding "EDF" has been stabilized around 20 TWh. The development of independent production through cogeneration has not yet had a noticeable effect on national production figures.

CO_2 emissions in the electricity sector amounted to 10 MMTC in 1990. Considering that the "EDF" fossil-fuel power plants were used less, these emissions dropped to 7 MMTC in 1993 and 1994. Because fossil fuel power production increased, these emissions reached 7.9 MMTC in 1995 and 8.6 MMTC in 1996.

Considering the situation of the nuclear and hydropower sectors (over 90% of electric energy production generates zero carbon, see the Section on National Circumstances), for its CO_2 emissions France has little mitigating room left to act on its electricity producing plants alone; France nevertheless intends to continue limiting emissions in this sector through two principal means:

- acting on demand for electricity to smooth the load curve

- developing the use of electricity as a substitute to fossil energy everywhere where this can reduce CO_2.

1.4.1. Investments in new nuclear power plants

Six new 1,300 MW PWR plants became operational between 1990 and 1994 and four PWRs of 1,450 MW are currently under construction, or for some already on-line, with full-scale operations scheduled before the year 2000. The nuclear infrastructure program for 1990-2000 concerns the production of a total 13,600 MW.

For example, basic operations of these ten plants, with availability at 82% and a rate of use of 85%, equals an annual production of around 84 TWh, with no CO_2 emissions. The same production from coal power plants, or combined-cycle gas plants, would generate respectively 25 or 12.5 MMTC/year.

"EDF's" infrastructure program for production means has acknowledged a noticeable slowdown in the rate of launching of new nuclear plant constructions, taking into account the slow growth in domestic electricity consumption, the high availability of the nuclear plants, the development of independent production (in particular cogeneration), and the lengthening of the life-expectancy of coal-fired power plants.

Considering anticipated trends in the balance between supply and demand for electricity, new nuclear plants will not have to come on-line before 2010.

1.4.2. Electricity exports

Electricity exports have been growing rapidly since 1990 (see table below). The electricity trade balance with other countries has risen from 46 TWh in 1990 to 69 TWh in 1996, i.e., a 50% increase in production compared with 1990. Corresponding gains in terms of CO_2 emissions can be estimated at 6 MMTC/year, assuming that French electricity exports are mainly replacing coal-fired production abroad.

YEAR	EXPORTS (TWh)	IMPORTS (TWh)	TRADE BALANCE (TWh)
1990	52.4	6.7	45.8
1991	58.7	5.5	53.2
1992	58.5	4.7	53.8
1993	65.1	3.7	61.4
1994	66.9	3.7	63.2
1995	73.0	3.0	70.0
1996	72.6	3.6	69.0

Contracts currently being signed will enable these exports to continue at around 70 TWh by 2000. However, considering excess production capacity in most of France's neighbors, increased competition among foreign producers caused by the opening of the internal electric market and problems with the construction of new interconnection power lines, the export balance will probably not be maintained at current levels beyond the year 2000. A volume of 50 to 55 TWh seems more realistic by 2010.

1.4.3. Development of cogeneration

Since the early 90s, there has been a renewed interest in cogeneration in France, with the near-exclusive development of combustion turbines and gas engines, whereas the older units were for the most part, steam turbines. Installed power reached 3.2 GW as of Jan. 1, 94, including 2.4 GW for steam turbines.

This situation was made possible by a regulatory provision that obliges that "EDF" purchase electricity produced by cogeneration facilities of a size under 8 MW. Beyond this

limit, a ministerial authorization is required; the Ministry of Industry has agreed to approve this type of project up to a cumulated power of 1 GW in the year 2000. The purchase rate is determined by reference to the offset costs for "EDF" assuming financially balanced production facilities (i.e., marginal long-term cost).

A study by "ADEME" estimates the economic potential of cogeneration in France, in the industrial and commercial sectors (excluding district heating), between 5 and 10 GW, depending on whether one relies on return investment payback of 5 or 12 years. This capacity would be added to existing facilities.

Considering current facilities, the prospects for the development of cogeneration are estimated at 6 GW over the 1995/2020 period. It is likely that because of seasonal variations in purchase rates, this equipment would operate mostly under winter rates and that electricity generated by this method would replace for the most part fossil-fuel produced electricity. The foreseeable impact in terms of CO_2 emission reductions is indicated below:

	2000	2010	2020
New cogeneration capacities (GW)	1.5	4	6
Electric production (TWh/year)	9	24	30
CO_2 impact (MMTC/year)	1.6 (*)	1 (**)	1.2 (**)

(*) replacing coal-fired power plants.
(**) replacing combined-cycle gas power plants.

1.4.4. Reducing peak demand curves.

Reducing peak demand curves and especially seasonal winter peaks is being actively sought because it would permit an even greater reduction in fossil fuel power plants hours of operation.

Such reduction is sought to save electricity and to shift some of the consumption times.

For this reason, "EDF" has developed a sophisticated rate system and has just implemented a low voltage "TEMPO" rate that offers six time periods at different prices during the year and will contribute to stabilizing the annual demand curve with a reduction during winter peaks and lesser use of fossil fuel power plants. Around 70,000 accounts have been opened at this time, this represents less than one-third of the targeted objective for 1996. Marketing efforts are being implemented to catch-up on the lag and reach one million homes of account holders around the year 2000. By then, the "TEMPO" rate will represent 5.4 TWh/year in terms of electric consumption; the drop in consumption during peak hours could reach 1.5 TWh/year, i.e., a reduction in emissions of around 0.35 MMTC/year. In 2010, the impact of these measures may be estimated at 0.5 MMTC/year.

Moreover, the cooperation agreement in the field of demand side management ("DSM"), signed in February 1993 between "EDF" and "ADEME" for a 3 year period, was renewed in 1996. It will enable extending on a national scale a certain number of pilot actions conducted at the regional level (distribution of low-energy lamps, promotion of efficient uses

of electricity in industry, etc...). Reductions in emissions resulting from these policies would at most reach 0.5 MMTC/year by 2010.

1.4.5. Substitution of electricity to fossil-fuels at the final consumer level

The state planning agreement covering 1997 to 200 renewed, for "EDF", a business priority of promoting efficient applications for electricity in industry.

1.4.6. Unwanted side-effects of electricity rates equalisation

Adjustments of the rates of low voltage electricity over the entire French territory masks electric production and distribution cost disparities and results in electricity being sold under its real cost, on the one hand in remote regions where electricity is essentially produced from fossil fuels (Corsica, Overseas Districts and Territories, see further ahead), on the other in low-density rural areas, whereas it is sold above its real costs in urban areas.

This situation has two consequences that deserve to be corrected:

- On the one hand electricity has an artificial advantage compared with new and renewable energies which in rural areas, the Overseas Districts and Corsica, would have a niche in which they may be profitably and efficiently developed. New and renewable energies are ones used to produce electricity or to replace it.

- On the other hand electricity price adjustments generate additional consumption compared with a rate reflecting real costs. This entails in remote areas that are not connected to the continental network, mostly supplied by nuclear and hydropower, additional CO_2 emissions estimated at 0.15 MMTC/year.

Promoting DSM and renewable energies in low-density rural areas has been ensured since 1995 through the implementation of a specific installment within the scope of "FACE" (Fund for the depreciation of electrification costs); of an initial amount of 100 MFF at its creation in 1995.

In 1995, selected projects reached, for DSM, 5.5 MFF and, for new and renewable energies ("ENR"), 63.2 MFF, i.e., a total of 68.7 MFF. In 1996, these projects represented 5.3 MFF for DSM and 23.8 MFF, or a total of 68.7 MFF. For these years, most of the equipment was photovoltaic (85%) windpower and hydropower equipment representing respectively 13.5 % and 1.5 %. At the current stage, the impact of these projects in terms of fossil carbon emissions' reduction is still low.

In the Overseas Districts, where electricity, for the most part, comes from fossil fuels, "ADEME" and "EDF" distributed over a million low-energy consuming lamps in the early 90s. These two organizations were also responsible for supervising a plan to distribute 20,000 solar water heaters; sales in 1996 (a little over 5,000 units) show that the objective should be reached by 2000. These two actions should enable a reduction in fossil carbon emissions in the Overseas Territories of around 11,000 TC/year by 2000.

Moreover, an experimental label was launched in 1996 for the purpose of promoting, in these Districts the design of housing units with bio-climatic architecture to avoid or alleviate

the use of artificial air-conditioning; these housing units should, moreover, employ efficient solutions to produce hot bath water.

1.5. Increasing forest carbon sequestration

1.5.1. Trends in tree-planting policy

Begun early in the last century, the expansion of forest land in continental France during an initial stage moved slowly: from around 7 million hectares in 1830, it reached 11 million hectares over a century later (in 1945), sometimes increasing or stalling in the meantime (in particular between the two World Wars). When the National Forestry Fund ("FFN") was established in 1947, a new impetus was given to forest growth, with acreage increasing to nearly 15 million hectares in 1990, leading to a percentage of total forest land of around 27%.

The expansion of French forest land has averaged 63,000 ha per year since 1945, this increase includes annual natural expansion (natural fallow growth) and tree-planting (planting on non-forest land). The "FFN" subsidized on average tree-planting on 21,000 ha per year over the period, starting with a high rate in the fifties (30,000 ha per year) to around 10,000 ha per year during the 80s.

In 1993, France decided on an objective of gradually increase the annual rate of subsidized tree-planting up to a level of 30,000 ha/year in 1998. In 1994 and 1995, 12,000 ha and 11,000 were respectively subsidized. Due to budget constraints, the objective of annual increases in subsidized tree-planting was finally abandoned and expectations are that the rate will be maintained at 10,000 à 12,000 ha/year until the end of the decade.

1.5.2. Measures implemented

The policy of public assistance in encouraging forest growth applies to reforestation of forest land (which, in particular, helps improve forest quality and recreate forests destroyed by disasters), as well as expanding forest acreage (tree-planting).

The subsidy mechanism for initial investments has been completed, since 1994, by the payment of a bonus to farmers or landowners as compensation for lost revenue. Fifty percent of the corresponding expenses are covered by the Community budget within the scope of measures facilitating the reform of the Common Agricultural Policy.

This mechanism is completed by various tax benefits (e.g., partial exemption of the tax on non constructed property and the inheritance tax).

1.5.3. Impact in terms of carbon sequestration[1]

A growing forest enables lasting carbon sequestration of the above and below ground tree biomass. For forests located on former agricultural lands, carbon is also sequestered in soil organic matter.

In 1990, the annual production of forestry biomass was around 56 million tons of dry matter, corresponding to the sequestration of 28 million tons of carbon. Considering the quantity of harvested wood, the increase in carbon sequestration contained in forestry biomass reached 12 million tons in 1990. In 1994, considering the decrease in harvesting and increased growth compared with 1990, the increase in carbon sequestration of the forestry biomass reached 14.3 million tons per year.

Simultaneously, there has been an unknown amount of carbon sequestration in soils, probably around 1 to 2 million tons (studies underway will clarify this issue, see Section VIII-2-2-2).

Considering the tree-planting policy described here, annual carbon sequestration in French forests should rise from an annual rate of 12 million tons of carbon per year in 1990 to 17 million tons of carbon per year in 2000, under the combined effect of an increase in annual biomass production (+2.7 billion tons of carbon per year) and a drop in harvesting (-2.3 million de tons of carbon per year), 1990 being an unusually high year for harvesting of lumber wood.

Furthermore, because of an increase in forestry acreage of around 110,000 ha by the year 2000, the amount sequestered in the biomass must be increased by a small amount, probably less than 0.10 million tons per year, to take into account soil[2] carbon sequestration.

The cost of tree-planting on farmland, related to a ton of carbon sequestered in the forestry biomass and the soil, is on average of 370 FF/t.

1.5.4. Forests-fire protection

On average over the last decade, around 4,700 fires spread each year over 31,000 ha of forests, moors, bushes and scrublands. With two fires out of three the Southern Mediterranean is the area most at risk, but the risk is also high in the Southwest and West of France during major drought years.

The policy of forests-fire protection includes:

* preventive actions, with three facets:

- increasing public awareness of the danger of bringing accidental sources of heat into the forest,

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[1] Estimates indicated in this section cover all "woods and forests" and "poplar groves"; they do not include "forested areas outside of forests", that only represent a small share in annual production of forestry biomass and on which little reliable data is available, in particular in terms of growth.

[2] This estimate does not take into account the natural expansion of forest land, which will likely follow the rate observed over the recent past (+50,000 ha/year), nearly compensating the trend of forest transformation into "follows, moors" or artificial soil use.

- monitoring fire starts through stationary observation posts and with fire patrols,

- building and maintaining infrastructures for the improvement of forest stands: trail maintenance, water points, clearance areas, firewall clearings,...

Most of the budgetary funds are focused on the last two facets.

* building fire-fighting means and their implementation by firefighter teams from the relevant local communities (totaling 27,000 firefighters), backed by a national system that includes an airborne intervention force (28 water bombers) and a ground intervening force of 1,7000 firefighters.

For high-risk districts, the state's financial effort amounted in 1995 to a higher level than that of the European Union (13 ECU/ha/year for France versus 6.5 ECU/ha/year for the Community average). Over the medium term, it enables limiting annual damage to 0.29% of forest land subject to risk, versus 1.08% for the Community average.

1.6. Carbon emissions linked to changes in agricultural land use

The major trend of diminishing farmlands which benefits forests, "unused" lands (moors, fallow lands) and artificial soil use, should continue during the 90s (-120 000 ha/year over the long-term).

Moreover, public incentives affecting land use within farming acreage have been changed.

Before 1993, the Common Agricultural Policy ("CAP"), through in particular a mechanism of price supports for producers, strongly encouraged increased agricultural production, causing a conversion into arable land, of grasslands (temporary and permanent pastures) and to a lesser extent, of forest land (the clearing of forest land continued until recently in some regions even though, at the national level, there was a strong increase in net forest land).

CAP reform should put an end to these trends:

- on the one hand, it was believed that there no longer were any strong incentives for increasing the acreage of arable crops (these new lands could receive hectare-based subsidies paid to producers of arable crops only in exchange for a reduction in the average subsidy level per hectare and the imposition of an exceptional set-aside the following year),

- on the other hand, cattle raising would not be encouraged to increase production by lowering grassland acreage and by replacing these with cultivated fodder or other vegetable crops (subsidies granted, in particular in the beef sector, are limited by the number of animals per hectare of fodder acreage, to a level that is nevertheless rather high, and corn-fodder acreage remains outside the mechanism).

Therefore, it seemed reasonable to except an end to pasture or forest conversions into farmland. In fact, this has not occurred up to now and recent modelling work show that the

economic advantage linked to intensified farming remains sufficiently strong for pasture or forest conversion into farmland to continue until 2000. Beyond that, it would be prudent to wait for the results of thinking underway on a new stage in modifications to the Common Agricultural Policy.

Finally, the Common Agricultural Policy now has a mechanism for mandatory set-asides of part of the acreage of arable crops, which will influence the growth of organic matter in lands concerned by this measure.

Impact regarding greenhouse gases

It is now estimated to be highly unlikely that changes in the use of lands, as explained in Appendix III, will take place by the year 2000; a decrease in annual carbon emissions of around 2 million tons compared with 1990 levels should not occur by then. It may well take place later over the 2000/2020 period.

1.7. New and renewable energies

Renewable energies represented in France, in 1990, 22% of national production of primary energy with 22.9 million toe, including 12.9 million toe for hydropower. In 1995, the production of renewable energy reached 29 million toe, including 17 million toe for hydropower

Renewable energies therefore offer a real asset in terms of energy, in economic terms and under certain conditions in environmental terms, developing these energies is encouraged in different sectors.

1.7.1. Developing wind energy use

In 1966 France launched a plan to develop wind energy. The objective was to implement by 2005, a wind energy electric production capacity of between 250 and 500 MW, depending on the economic value of the targeted projects. Each potential operator states through competitive bidding the purchase price for electricity required to render the project viable.

In 1993 and 1994, two plants of 2.2 and 3 MW were built respectively in Port la Nouvelle and Dunkirk. By 1997, opening of the two first phases of the competitive bids should lead to choosing projects equaling a total installed generating power of 50 MW.

Considering the size and structure of all the national electric power plants, impact in terms of mitigation of CO_2 emissions will remain limited until 2005 (below 50,000 TC/year).

1.7.2. Developing the use of wood energy

With over 10 million toe, wood is in third place in national energy production.

Over 80% of wood energy is used for individual heating: nearly a quarter of house use it for basic heating and another quarter for extra heating. This traditional consumption, thought not well studied (because, for the most part, it is outside commercial networks), appears to have been rather stable over the last ten years, with a replacement of traditional

methods (cooking stoves and heaters in old houses) by new methods (closed fireplace in new houses, in particular as an addition to electric heating).

Consumption for the heating of buildings or commercial premises is a recent development and represents around 0.1 million toe per year; it concerns around 200 central heating systems implemented with assistance from "ADEME" over the last ten years.

Finally the wood and paper industry consumes a little over 1 million toe per year in waste and wood by-products.

Additional available resources are composed of the following:

- a low-cost source between 0.2 and 0.4 million toe/year as wood by-products or waste;

- a source, at a high collection cost, of wood harvested in forests representing up to 3 million toe/year (gathering would be carried out ensuring that the resource is managed sustainably);

- of wood from hedges and short rotation forestry that can be planted close to where it is consumed, for example on set-asides of "arable crops" established by the CAP;

Moreover, thanks to a constant renewal of combustion materials, gradual improvement in energy performance of the equipment would allow for increasing the actual contribution, in terms of fossil energy savings, of the currently exploited source (by 2015, this process could free between 1 and 2 million toe of wood in housing heated with wood in 1990, i.e., a potential reduction of fossil energy consumption of the same amount).

Two type of specific actions have been decided, furthermore, to strengthen the position of wood energy in France's energy supply:

- the rate disadvantage of wood energy caused by the below-rate price of low-voltage electricity (due to rate adjustment) should be rectified in low density areas (see section III -1-4-6);

- A "Wood Energy Plan" has been implemented under which the state and local authorities in a number of pilot regions, intend to create the conditions needed for organizing a real wood energy sector for central heating, acting both on supply (wood supply, installation and maintenance of combustion equipment) and demand (in particular in government building and housing).

Measures implemented

Within the scope of a Wood Energy Plan, the development of wood use in central heating systems has been encouraged by the payment by the public budget (state plus local authorities and possibly the European budget), of all or part of:

- feasibility studies,

- equipment need for the sector supplying the product (harvesting, storage, packaging),

- excess costs of investments in heating systems, compared with competing options,

- facilitation, training and assessment.

Subsidies are contributed on a case-by-case basis depending on the local context, so that the biomass option is attractive compared to competing fossil-fuel energy options.

The planned public budget for the 1995 - 1998 period totals 148 million French francs.

Moreover, France obtained the inclusion of wood energy (non-processed products) on the list of products that could be taxed at the lower VAT rate, annexed to the sixth European directive. This measure should, first help develop wood energy and, second, encourage the integration of the sector supplying individual heating into commercial networks. This should improve an economic activity (felling, transportation, woodworking) providing around 25,000 jobs in France. A first step was made in the 1997 Budget law which provides for a lower VAT rate for wood used for home heating.

Impact in terms of emissions

French forests are managed sustainably, carbon released during wood combustion must not be taken into account. However, wood combustion releases greenhouse gases other than CO_2, such as CH_4, N_2O, that diminish the positive contribution of wood use to the mitigation of climate change.

Renewal of existing equipment by higher performance ones, lowering CH_4 and N_2O emissions, should substantially increase the contribution of wood energy to combatting the greenhouse effect in the future, however, considering the life expectancy of equipment, this change will certainly be slow.

Overall it can be estimated that, under current circumstances, the use of the 10 million toe of wood allows offsetting emissions of around 5 million tons of fossil carbon.

The measures described here, as well as the expansion of the “TEMPO” rate (that increases the economic value of a wood/electricity combination) should permit maintaining the level of wood consumption in individual heating in the year 2000, or even increasing it after 2000.

The wood energy Plan provides assistance for installing up to 250 central heating systems in thirteen districts or regions, representing a foreseeable consumption of wood of 70,000 toe. This will permit offsetting, over time, emissions of around 55,000 tons of fossil carbon, while creating over 260 jobs, mostly located in rural areas. As of January 1, 1997, 39 heating systems, with a total capacity of 46 MW for an annual consumption of 12,500 toe had been implemented.

But the real stake is over the long term: the issue is to promote an organization of the sector allowing it, in the event of a significant change in the energy situation, to grow substantially. A prospective study concluded that, considering the available resource and in particular its geographical distribution, and depending on the trend in prices for the final user of fossil energy (taxation of fossil carbon), wood consumption in the heating of buildings and industry could triple by 2020, going from 1 to 3 million toe per year.

1.7.3. Development of agricultural biomass production for energy use

The production of energy with a low fossil carbon content is one of the best methods over time to meet the ultimate objective of the Climate Convention. Moreover, France has a dynamic and efficient agricultural sector, that is particularly affected by weak world market outlets for food.

In order to respond to this two-tiered challenge, a scientific group Agriculture for Chemistry and Energy ("AGRICE") has been entrusted with coordinating various research actions conducted at the national level. Its working program is focused in the following three directions:

- bio carfuels (in the short term, rapeseed methyl ester - RME - and ethanol from carbohydrate plants, in the medium term, ethanol obtained through fiber hydrolysis or hydrocarbons obtained through hydroprocessing of fast pyrolisis oils)

- the lignocellulosic plant stream (short rotation coppice, herbaceous plants, "whole plant" grains), leading to biofuels (these are rough biomass burned directly in boilers, or if need be vectors of more sophisticated energy such as plant charcoal fuel suspension or stabilized fast pyrolisis oils),

- non-food and non-energy production (biopolymers, ecoproduct detergents, ...) which displace some fossil carbon used in organic chemistry.

Simultaneously, France has launched an industrial scale experiment in the production and distribution of bio carfuels:

- sugar seet and grain ethanol is used to produce Ethyl Tert-Butyl Ether (ETBE), which is a compound that enriches octane rating and may be used as an additive up to 15% in premium gasoline: in 1996, thus, 55,000 tons of ethanol fuel were produced (for 122,000 t ETBE); by 2000, this production should exceed 110,000 t/year;

- rapeseed methyl ester is used, on the one hand, as an additive up to 5% in diesel distributed in service station as well as in domestic heating fuel, and, on the other, at a higher percentage, in company fleets, in particular municipal buses; 1996 ester production reached 224,000 tons; by 2000, estimated production will be 400,000 t/year.

Measures implemented

Public incentive funding for "AGRICE" since 1994 has reached around 40 million French francs, in addition to between 25 to 35 million French francs per year awarded by professional farming organizations.

Since ethanol and RME costs are much higher than those of petroleum fuels, at current oil prices, they have been exempted from the domestic tax on petroleum products to facilitate sales.

The level of tax-exemption is limited to 230 FF/hl for rapeseed methyl ester and to 329.50 FF/hl for ethanol, this would represent by 2000, a loss of tax revenue for the state of 1,500 million French francs per year. These exemption represented a total of 1,200 million French francs in 1996. Research carried out by "AGRICE" should reduce the cost by half within 10/15 years.

Anticipated results

Experiments conducted in the automotive fuel sector should offset 270,000 t of fossil carbon emissions by 2000; this estimate takes into account uses of fossil energy taking place during the biomass fuel production process.

The measures were essentially undertaken for agricultural policy reasons; they are not cost-effective from the exclusive point of view of combatting the greenhouse effect. In fact, if their cost were affected to fighting the greenhouse effect, it would reach 40,000 FF/t offset carbon for the ethanol compound and 3,900 FF/t C for the ester compound (this cost is extremely high in the case of ethanol because the production scheme relies on existing facilities that are not energy optimized).

It is likely that biomass fuel production (in particular on mandatory "arable crop" set-asides implemented within the scope of the Common Agricultural Policy reform), used for central heating or for generating steam in industry, will be in place by 2000; however, its volume impact will remain limited because of the delay. The cost of this action should be below 500 FF/t offset carbon.

1.7.4. Waste energy use

The law of July 13, 1992 modified waste management (municipal and ordinary industrial) by increasing the promotion of recycling. Waste that cannot be recycled as a material or in agriculture will be preferably and for the most part incinerated to produce energy. The primary energy should rise from 1 Mtoe/year in 1990 to over 3 Mtoe/year in 2002.

In spite of advances in stack scrubbing, eliminating any actual danger, there still is strong opposition to acceptance by public opinion of the installation of incinerators sufficiently close to urbanized areas to directly make use of the heat produced, as would be desirable. Efforts to inform will be undertaken, with the help of the relevant local authorities, to allow the connection of incinerators to district heating. Indeed, when the energy's value can only be used through the production of electricity, it reduces the need for nuclear electricity but does not have an impact on CO_2 emissions in the current context.

Overall, the estimate is that CO_2 emission reductions caused by enhancing the valorisation of energy produced from waste-to-energy incineration could rise from 0.55 million tons of carbon in 1990 to 0.75 million tons of carbon in 2000 (continuation of the trend of an increase in the share of energy generated from waste in supplying existing district heating networks).

In the Overseas Districts, the implementation of a strategy to enhance the energy value of bagasse in efficient combined bagasse/coal electric power plants (two units of 55 and 60 MW installed in 1992 and 1995) will permit the reduction of fossil CO_2 emissions by around 100,000 t C/year by 2000.

1.7.5. Hydropower

Hydropower is the largest current French renewable energy source, has great value for the greenhouse effect, in particular when used to meet peak electric demand replacing fossil-fuel generated electricity.

But hydropower is also questioned because of other damage it does to the environment or because it competes with other water uses.

By the year 2000, France will be committed to preserving the CO_2 savings that hydropower allow but cannot expect to significantly increase these.

2. Methane emissions

2.1. Agricultural sector methane emissions

Methane emissions in the agricultural sector are essentially produced by two sources: enteric fermentation of ruminant domestic livestock and anaerobic fermentation of animal waste from livestock farming.

The factors causing these emission are still not well known. Action-oriented policies to reduce these emission per unit generated can only occur once research underway is completed (see Section VIII).

2.1.1. Activity trends in livestock

Trends in French agriculture between 1990 and 2000 will be influenced by the Common Agricultural Policy (CAP) reform, that was spread over the 1993/1996 period, and the GATT agreements (Uruguay Round cycle), that will be implemented over the 1995/2000 period and will result in a reduction in supports for exports on the world market.

Projections on the level of livestock production for 2000 have been revised with assistance from the "MAGALI" simulation model of French agriculture, completed by expert opinion.

Overall, projections, for the 1990/2000 period, at the average annual rate of change for the following productions are:

- milk 0 %,
- beef 0 %,
- pork +2.7 %,
- poultry +3.4 %

compared with average annual trends observed over 1990/1995:

- milk -0.5%,
- beef -0.4%,
- pork +4.3 %,
- poultry +4.9 %

Thus, the volumes of production of pork and poultry should continue to grow over the 1996/2000 period, but at a slower rate than over the 1990/1995 period.

2.1.2 Impact in terms of methane (CH_4) emissions

2.1.2.1 Enteric ruminant fermentation

* Methane emissions caused by milk production[1] can be estimated at 0.66 million tons in 1990. Continued increase in production[2] will result in a drop of unit emissions of methane per liter of milk produced compared with the 1990 level estimated at 15%: emissions in 2000 should equal 0.60 million tons.

This projection does not include potential fallout from research on determining the cause of emissions from ruminant enteric fermentation, described in Section VIII; emission could therefore be lower than the figures indicated here.

* Methane emissions caused by the production of beef can be estimated at 0.66 million tons in 1990.

A balancing in favor of more extensive[3] forms of production and a decrease in the number of calves in dairy herds will result in an increase of methane unit average emissions (per kg of meat produced) of around 10%.

Total emissions should be close to 0.74 million tons of methane in 2000.

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[1] dairy cows plus founding heifers

[2] A 9.5% increase in milk yields over the 1991/1995 period was observed, i.e., a continuation of medium term trends.

[3] The negative impact in terms of methane emissions of the extensification of beef production is compensated by a positive trend in terms of carbon sequestration in lands where plant production furnishes nourishment for the cattle herds: a higher proportion of pastures and less lands with cultivated fodder, lesser intensification of pastures. This aspect is analyzed in § III-1-6-.

* Globally, the trend in methane emissions linked to enteric cattle fermentation between 1990 and 2000 should equal 1.34 million tons of methane, i.e., near standstill compared with 1990.

2.1.2.2. anaerobic fermentation of animal waste

In 1990, methane emissions from anaerobic animal waste fermentation were estimated at 0.18 million tons.

Continued improvements in animal productivity should automatically lead to a decrease in the volume of animal waste produced per unit. Related methane production will depend on the trend in management of animal waste.

A major program to control agricultural-source local pollution was implemented in early 1994; its aim was to improve the conditions of production in intensive livestock farming with respect to the local environment and in particular water resource protection (combating nitrate pollution). This will help with a series of investments at the farm level, in order to increase storage of animal waste (manure) (of around +30 to +50%) to better manage spreading.

This trend will predictably cause an increase of around 40% of the average storage time and an equivalent increase in methane emissions. Research underway should furnish technical elements needed to include, in this program focused on local pollution, a control of methane emission (see Section VIII).

Moreover, it is very likely that, in areas that have significant excess amount of animal waste compared with the absorption capacity of the soils, manure processing plants will be built; the volumes involved, for which estimates have not yet been calculated, will no longer be stored over long periods; therefore, methane emissions will decrease. The figures presented below to not take into account the factor of a likely decrease in methane emission, since its size has not been calculated.

Finally, a relative decrease in intensive beef livestock farming will decrease in priority the volume of animal waste with the highest methane generating potential in this sector.

Trends in methane emissions caused by animal waste from livestock farming are summarized in the following table: overall, indications are a likely increase of 28% in these emissions between 1990 and 2000, i.e. + 50 000 tons of methane.

	Methane emissions in 1990 (1000 t)	Animal production trends (% over the decade)	Trend in volume of unit animal waste (% over the decade)	Impact of the management method (% over the decade)	Methane emissions in 2000 (1000 t)
Beef cattle, including:	95				114
** liquid and solid manure mix*	*53*	*-5*	*0*	*40*	*70*
** manure, in the fields...*	*42*	*+5*	*0*	*0*	*44*
pork	45	30	-8	40	76
poultry (incl. eggs)	23	39	-10	40	38
total	178				228 (+ 28%)

2.1.2.3 Overall trend

Foreseeable trends by 2000 in livestock farming sector activity should lead to a slight increase in methane emissions: as an over-estimation, emissions increase could reach 70 000 tons of methane.

livestock farming methane emissions (1000 t CH4)	1990	2000	1990 / 2000 trend
enteric fermentation	1320	1340	+ 20
animal waste fermentation	180	230	+ 50
TOTAL	1520	1570	+ 70

2.2. Landfill methane emissions

In 1990, out of around 20.5 million tons of municipal waste, a little over 50% was landfilled, 9 million tons incinerated and one million tons composted.

The quantity of ordinary industrial waste similar to municipal waste represented 40 million tons in 1990, of which 25% was landfilled with household waste, and an undetermined

amount stored in company landfills, most of the remaining waste was recycled, in particular in agriculture.

Overall, the estimate is that around twenty million tons of waste considered as minicipal waste was landfilled in 1990

2.2.1. Ordinary waste will no longer be landfilled

The objective of the law of July 13, 1992 was to radically change waste management, in particular by promoting increased recycling; thus it will only permit the landfilling of so called "ultimate" waste in 2002, i.e., the portion of remaining waste following recycling and processing using best available technology at an acceptable economic cost. This implies in particular:

- that stored waste are only slightly or not at all subject to decaying, eliminating source emissions of methane,
- that waste in which materials are not recycled or used in agriculture, should preferably and for the most part be incinerated for energy recovery.

2.2.1.1. Impact of the measure

Current emissions from all the former and currently operating landfills in France has been estimated at 0.46 million tons of methane in 1990, using the "first order kinetic method", relying on the gradual decaying of waste over 30 years. In this context, the "past" has a crucial impact on current emissions, and all actions to reduce landfilled volume can only become really effective over the medium and long term.

Implementation of the law of July 13, 1992 should almost result, as of July 1, 2002, in the elimination of methane emissions from newly generated waste.

Potential methane emissions can be estimated at 0.80 million tons in 2000, i.e., an increase of 0.22 million tons/year, in spite of a drop of 35% in annual landfilled waste since 1990. After which the decrease will be gradual, reaching 0.52 million tons in 2010, 0.23 million tons in 2020. These emissions should nearly completely disappear in 2030.

2.2.1.2. Costs of the implementation of the law of July 13, 1992

Implementing incineration or composting plants needed to apply the law of July 13, 1992, is expensive: initial estimates (assessment underway within the scope of the review of the European directives on municipal waste), investment costs by 2002 to upgrade and expand the number of waste processing plants will range from 40 to 50 billion French francs.

These expenses must be incurred by the relevant local authorities. A waste management modernization fund has been established to assist in implementing the law. The fund is financed by a tax, its initial amount was 20 FF per ton of landfilled waste and increased

to 35 FF/t in 1997 (this amount should further increase to 40 F/t in 1998); the funds income should reach 780 MFF in 1997.

2.2.2. Landfill methane recovery

In 1996, 72 landfills representing an annul volume of 5.4 million tons per year of waste (i.e., around 25% of the total landfilled volume) stated they were recovering landfill gas and flaring it.

A draft ministerial order will make it mandatory, at the latest by mid-1999, to recover methane released in operating landfills. Moreover, the "ADEME" has implemented a program to assist with the restoration of landfills that are being closed, including by installing a methane recovery equipment on sites that require it. The assumption can be made that all currently operating landfills or that have closed after 1995, will gradually be equipped with a device to recover landfill gas by 2000. Based on a recovery rate of 80%, this action is estimated to lead to a decrease in CH_4 emissions respectively of 0.40, 0.41 and 0.20 million tons per year in 2000, 2010 and 2020.

Cost of the measure

Based on the average investment cost of 1.4 MFF / landfill hectare for the recovery device, the cost per m^3 of recovered methane would reach 0.35 FF, i.e. around 90 FF/TCE (GWP over 100 years, according to IPCC 1995)

2.3. Natural gas leaks in the distribution networks

In general, natural gas leaks are very low, and it is extremely difficult to give precise figures, because they remain below levels measurable by instruments.

Nevertheless it appears established that the level of leaks varies greatly depending on the transmission and distribution mode used:

- for transmission networks leaks are considered to be near zero;

- for distribution networks, there are two types of leaks:

  . line leaks, proportional to the length of the network, and for which unit levels vary depending on the type of pipeline (welded steel, polyethylene or brittle cast-iron, the latter are the weak links in the distribution networks),

  . accidental leaks, essentially linked to various operational incidents that could lead to methane releases, and that are even less well known.

The French gas utility ("GDF") is pursuing an active policy of renovating its distribution network. It covered in 1990 a total length of 144,000 km, including 17,000 km in gray cast-iron. "GDF" has been replacing 9,000 km of the old network between 1990 and 1995, and intends to continue its old network renewal effort over the 1995 - 2010 period.

Moreover, the constant improvement in management procedures for operating incidents has reduced the number of accidental methane leaks.

These actions are primarily concerned with improving safety, but they are useful in combating the greenhouse effect.

Leaks linked to distribution networks are therefore expected to be significantly reduced over the 1990 / 2010 period, in spite of the rapid growth in the consumption of natural gas over the same period.

	1990	1995	2005	2010
Level of leaks (1000t CH_4/year)	100	84	76	73
Impact of the measure (1000t CH_4/year) (*)	-	33	64	76

(*) assuming that if the measure had not been taken the unit level of leaks observed in 1990 would have remained the same.

2.4. Coal mine methane

Most CH_4 released in former or current French mining activities is recovered and used for heating. In 1996 estimates were that non-recovered mine gas emissions in France represented less than 20% of the total.

Considering the planned decrease in French coal production, leading to an end to all production in 2005, and in view of the requirements that will probably apply to mining facilities after that date (exhaust maintenance, ...), non recovered mine gas can, at present, be estimated at around respectively 50, 29 and 14 thousand tons by 2000, 2005 and 2010.

3. Emissions of nitrous oxide

3.1. Reduction measures in the industrial sector

All of the facilities referred to in this paragraph released relatively large volumes of nitrous oxide in 1990 depending on the processes employed; these emissions will be radically reduced by 2000.

But, at the same time, efforts undertaken to reduce NO_x emissions in other facilities may lead to a increase in emissions of nitrous oxides. This phenomena should be controlled with appropriate technologies. These technologies are, however, already planned, even implemented in sectors producing adipic acid. The anticipated effects on NO_x emissions are detailed in § 4.

3.1.1. Adipic acid

Adipic acid production releases the most nitrous oxide. It is produced in only one site in France. In 1990, emissions were estimated at 55,350 tons. In 1995, they were

estimated at 56,600 tons. Pursuant to a Prefectoral order of August 23, 1993, facilities processing the gas effluents will be implemented by the end of 1997 enabling a reduction of 50,000 tons per year of N_2O emissions. A significant reduction of NO_x emissions will occur at the same time.

3.1.2. Nitric acid

In 1990, emissions from nitric acid units reached 25,600 tons of nitrous oxide and 16,000 tons of nitrogen oxide, excluding nitrous oxide.

Considering the economic context of the activity, plants have shut since. Nitrous oxide emissions from remaining plants reached around 13,600 tons in 1995.

Nitrogen dioxide emissions have been limited since 1993, in new nitric acid facilities to 1.3 kg per ton of 100% produced nitric acid and nitrous oxide emissions to 7 kg per ton of nitric acid produced.

For existing plants, Prefectoral orders will be issued by 1998 that will specify the implementation deadlines and objectives to be reached for each plant.

By the year 2000, estimates are that emissions from nitric acid units should reach 9,000 tons of nitrous oxide.

3.1.3. Glyoxylic acid and glyoxal

These products are manufactured in two plants in France. 1990 emissions can be estimated at 9,000 tons. In 1995, emissions reached 8,500 tons.

The company operating the two plants, must, pursuant to a Prefectoral order of June 6, 1996, concerning the plant located in the Oise District, implement a catalytic processing device reducing N_2O releases to less than 285 tons per year before December 31, 1997, this should result in a 95% reduction of these emissions. Regarding the other plant, the fact that one unit stopped production and that reduction measures are being reviewed for the other unit should also result in limiting releases of nitrous oxide by over 90%

3.1.4. Overall trend

At the level of these three industrial activities, nitrous oxide emissions from industrial processes were estimated at 90,000 tons in 1990 and 80,400 tons in 1995. Planned measures should lead by the year 2000 to the following emissions: 6,600 tons of adipic acid, 9,000 tons of nitric acid, and 500 tons of glyoxylic acid, i.e. a total of 16,100 tons equal to an 82% drop compared with 1990.

3.2. Nitrous oxide emissions in the agricultural sector

Emissions of N_2O are supposed proportional to nitrogen fertilizer use; the IPCC recommends considering both mineral fertilizers and organic fertilizers (essentially animal

waste). However, selective studies in France show a major link between the level of these emissions and soil and climate conditions and the type of crop in question (a factor of 1 to 10 for the same level of nitrogen fertilization has been observed). The major uncertainties regarding the volume estimates presented here should be kept in mind.

Uses of nitrogen fertilizers will change under a combination of several factors:

- The implementation of the mandatory set-aside provisions applying to arable crop acreage within the scope of Common Agricultural Policy reform, will lead to an automatic drop in fertilizer use, because of the decrease in farmland. It should be noted that the year 2000 level is still not known and that it has varied between 5 and 15% over the 1992/1996 period. Moreover, consideration should be made for the fact that by 2000, around one-third of the acreage subject to set-asides will be used for non-food productions for which nitrogen fertilization demands are similar to conventional crops.

- the trend towards a de-intensification in arable crop production as a result of the partial decoupling between public subsidies granted and the actual level of production is another consequence of Common Agricultural Policy reform. This should result in a drop in average nitrogen fertilizer per acreage unit for arable crops.

- The European directive on nitrates targets a sizable reduction in nitrogen pollution in so-called sensitive areas, which should concern around 10 million hectares in France; it will, in particular, result in regulatory restrictions of organic nitrogen use to 210 units per hectare before the end of the decade, followed by 170 units per hectare after the year 2000 (in intensive livestock farming areas these levels are often exceeded). In many Districts that are seriously affected by nitrate water pollution, local regulations based on the national good behavior code are being implemented with the objective, over time, of bringing spreading standards in conformity with absorption capacities of crops in the various regions. In some regions, it is estimated that overall use of nitrogen fertilizers in 1990, of which 40% were mineral fertilizers, were 35% higher than the potential exports of these crops. This trend will be encouraged by a decrease in waste per animal unit, of around 5% for pigs and fowl, obtained through the application of new feed standards and a resulting improvement in nutritional efficiency.

- Positive fallout from the “fertimieux” program, implemented in 1991, it strives to change the behavior of farmers and their advisers in order to prevent non-point source pollution of water by nitrates; this objective must be reached in particular through giving appropriate advice for the best management of nitrogen (optimizing fertilizer use and livestock effluent spreading, management of the interval between crop plantings,...)

In 1996, around 24,000 farmers, representing about 1.3 million hectares in farmland, in 46 Districts, essentially in sensitive areas, are participating in this program.

Overall, a noticeable drop in use of nitrogen fertilizers should be observed, in particular in livestock farming areas, affecting in priority mineral[1] fertilizers.

[1] Furthermore, an increase in the use of various by-products (in particular sludge from treatment plants) is anticipated.

The trend towards a limitation in use of mineral nitrogen is shown by the statistics beginning in 1990: it was drastic in 1993 (-15% compared with 1992, -18% compared with 1990). A rise was observed over 1993/1995, but the level reached in 1996 remains 10% lower than in 1990.

An estimate of the volume impact of the various factors by 2000 is proposed in the following table. A 14% drop can be anticipated in the overall use of nitrogen fertilizers (mineral and organic) resulting in an equivalent percentage drop in N_2O emissions, i.e., 7,500 tons of N_2O.

Nitrogen fertilizers (millions of ton of N)	1990 level	Impact of set-asides (2)	Impact of lesser intensification (3)	Impact of Nitrate directive (4)	Impact of "fertimieux" (5)	2000 level
total mineral nitrogen	2.65	-	-	-0.31	-0.02	2.11
total organic nitrogen (1)	1.15	-	-	-	-	1.15
including nitrogen for arable crops (1)	1.7	-0.11	-0.1	-	-	
N_2O emissions (1000t)	**59.7**					**52.2 (-14%)**

(1) estimates
(2) 10% set-aside rate including a third for energy crops
(3) relative price elasticity (of fertilizer versus the price of the agricultural products) in the use of nitrogen fertilizers of 0.2
(4) -20% of total nitrogen in intensive livestock farming areas (Brittany, Loire Region, Lower-Normandy) and -10% in other sensitive areas
(5) -10% of total nitrogen (over 1 million hectares) in addition to factor (4)

4. Tropospheric ozone – Combating precursor gases

Tropospheric ozone is more and more often considered as the "third" greenhouse gas, in the rank of contributions to climate warming, after carbon dioxide and methane.

Space and time distribution of ozone in the troposhere is influenced by several processes, including in particular, the photochemical production caused by the oxidation of natural or anthropogenic precursor compounds — methane, carbon monoxide, volatile organic compounds — with the addition of nitrogen oxides and solar radiation.

According to a report by the French Academy of Sciences (*"Ozone et propriétés oxydantes de la troposphère"*, October 1993), ozone has increased by a factor higher than 4

since the end of the last century, in the medium latitudes of the Northern Hemisphere. Moreover, on the same latitudes the combination of background increases with localized peaks, has generated concern over the impact of the ozone on health and plants.

This is why France has entered into several international commitments within the scope of the Convention on Transboundry Air Pollution within the UN Economic Commission for Europe:

- reductions in nitrogen oxide emissions of 30% between 1987 and 1998;
- reductions in emissions of volatile organic compounds by 30% between 1988 and 1999;

Reductions of around 30% will be made between 1990 and 2000. The means for the reductions that have already been adopted or are being contemplated are explained below.

4.1. National and European transportation measures

The provisions of the consolidated European directive of June 26, 1991 mandated new emission standards for all new passenger cars as of January 1, 1993, this led to the implementation on gasoline vehicles of catalytic converters and a little canister to recover evaporated hydrocarbons during the use of the vehicle. A new directive of March 23, 1994 made the maximum emission limits stricter for new passenger cars as of January 1, 1994, and required the implementation of an oxidation converter on diesel vehicles.

A new directive is under review by the Council and the European Parliament. It provides for two new stages in emission reductions for passenger vehicles in 2001 and 2005.

For vehicles over 3.5 tons, the directive "clean trucks" of October 1, 1991, determined two series of values applicable to new trucks as of October 1, 1993 and October 1, 1996. It strengthens already existing provisions. Small trucks are regulated by a directive of June 28, 1993, applicable to all new vehicles as of October 1, 1994. This directive was completed by a new directive of October 8, 1996 applicable as of October 1, 1997 or 1998 depending of the class of vehicle.

A new proposed directive on small trucks is now ready and a proposed directive on heavy trucks will be in the next few months. Corresponding directives should enter into force in the year 2000.

Finally, two directives on off-road mobile vehicles and another on two and three-wheel vehicles should be adopted in the next few weeks.

All these directive will enable a crucial reduction in CO_2 emissions and in VOCs and, to a lesser extend in NO_x caused by transportation.

In France, two bonus incentive programs to replace an older vehicle — a passenger car or small truck — (over eight years old) by a new vehicle, implemented from February 1994 to June 1995 for the first and from October 1995 to September 1996 for the second, allowed for anticipating the renewal of 1,700,000 vehicles, contributing thereby an additional reduction in emissions.

4.2. VOC reduction measures

4.2.1. Transportation

See above.

4.2.2. Solvent use

Solvents are used both industrially and domestically:

Industrial uses include some sectors such as printing, pre-lacquering, the automobile industry and dry cleaning, subject to specific national regulations on the release of solvents into the atmosphere, i.e., respectively the technical directives of April 5, 1988, of August 25, 1988, of June 11, 1987 and of July 3, 1995 and the standard order of No. 251. For facilities that are not covered by specific national regulations, the provisions that apply to industrial facilities that are major emitters are contained in the ministerial order of March 1, 1993 mentioned in § 3.1.2. These measures should reduce emissions by around 38% in the year 2000.

Other solvent uses are mostly found in building paints, paints for the general public and domestic solvent use. Technical advances in paints will encourage the spread of paints with less solvent content. For the general public and the building sector, water-based paints represented between 45 and 50% of total consumption in 1990. Incitement measures in particular ecolabels, continued and increased public information, means the consumption of these water-based paints will increase by 2000.

Finally, a proposed Community directive on the use of solvents in industry and covering user activities is under review by the Council and the European Parliament. This measure should lead to a sizable reduction in emissions for new and existing facilities.

4.2.3. Industrial processes

Anticipated reductions in this sector have not been precisely computed. However, the ministerial order of March 1, 1993 that applied to new facilities as early as 1994 and gradually, over a period of 5 years, to existing facilities if their releases are substantial, should lead to a reduction of at least half the VOCs in the chemical and oil industry sectors and a reduction of around 20% in industry overall.

4.2.4. Production and distribution of oil products

The implementation of the directives on the recovery of hydrocarbons along the entire gasoline distribution chain will reduce VOC emissions in this sector. Considering the deadlines proposed at the Community level, most depots areas and service stations should be equipped to recover gasoline fumes before the end of this century. This action should lead to a 32% drop in emissions.

The law of December 30, 1996 on air and the rational use of energy has also made the recovery of gasoline fumes mandatory by 1998 at the pump level for all service stations with an annual volume of other 3,000 m^3.

4.2.5. Other sectors

The sectors include fuel combustion, agriculture and waste processing. The overall contribution of these two sectors is low, the assumption made is a stabilization of emissions by the year 2000; for fuel combustion, anticipated gains are hard to quantify because emissions change depending on the type of fuel used; the increased use of gas is a positive factor that should permit a reduction in emissions. For all these other sectors, we have assumed a stabilization of emissions at the 1990 level, i.e. 345,000 tons.

4.2.6. Conclusion

The measures described in this section should permit a reduction of around 30% (i.e., around 780,000 tons) of VOC emissions in France between 1990 and 2000:

SECTOR	1988 - 1990 VOC EMISSIONS	2000 VOC EMISSIONS
Road transportation	1,100 kt	550 kt (-5 %)
Other mobile sources	100 kt	100 kt (=)
Industrial solvent use	400 kt	250 kt (-38%)
Domestic solvent use	240 kt	200 kt (-17%)
Industrial processes	85 kt	70 kt (-20%)
Oil production and distribution of oil products	140 kt	100 kt (-32%)
Miscellaneous	345 kt	345 kt (=)
TOTAL	2,400 kt	1,615 kt (-32%)

4.3. Reduction of NO_x emissions

Emissions of NO_x, a tropospheric ozone precursor, have an indirect impact on the greenhouse effect. The measures described below were taken for reasons of local and regional pollution — Geneva Convention in particular. Indirect impact on nitrous oxide emissions were mentioned in § 3.

4.3.1. Transportation

The European directive that apply to all new gasoline vehicles, mentioned in the previous paragraph are aimed in particular at reducing nitrogen oxide emissions. On the basis of these provisions, anticipated reductions in nitrogen oxides will be around 35%:

Road transportation	
NO_x emissions in 1990	NO_x emissions in 2000
1,038 kt	671 kt (-35%)

4.3.2. Electric production

Fossil fuel power plants will already be equipped with low NO_x flame burners by 2000. Considering, moreover, anticipated trends in the rate of operation of fossil fuel power plants in France by the year 2000, a sizable reduction of emissions compared with their 1990 level can be forecasted.

4.3.3. Industry

Provision have already been taken by means of national regulations (ministerial order of March 1, 1993, ministerial order on "glass", ministerial order on "cement factories", requiring a reduction in emissions of nitrogen oxides. These regulations on processes should be completed by the implementation of provisions for the reduction of emissions in all fuel combustion facilities. The anticipated results are the following:

	1990 NO_x emissions	**Projected 2000 NO_x**
Fuel combustion in industry + city heating	77,700 tons	54,400 tons
Energy processes	83,500 tons	41,500 tons
Non-energy processes	30,800 tons	14,800 tons

The last entry takes into account a reduction in NO_x emissions of 16,000 tons, with the implementation of nitrous oxide emission reduction processes.

Measures will be taken in particular in the two other major emitting sectors: other mobile sources (aircraft, two-wheeled vehicles, tractors,...) and individual boilers in the residential and commercial sectors that alone released 218,000 tons of nitrogen dioxide in 1990, to secure a reduction by an additional 70,000 tons in order to meet the objective provided for in the Sofia declaration.

4.4. Reduction in CO emissions

Transportation and to a lesser extent housing and the commercial sector are the major generators of carbon monoxide emissions. The implementation of the 3 channel catalytic converter on gasoline vehicles, and the oxidation converter on diesel vehicles has allowed a reduction in carbon monoxide emissions of over 1 million tons, i.e., a reduction of more than 10% compared with overall French emissions. Following the scenario referred to here, carbon monoxide emissions of passenger cars, light trucks and heavy trucks would be respectively reduced by 65%, 40% and 40%. Thus, the anticipated reductions in CO emissions can be estimated at 750,000 tons between 1990 and 2000, i.e., still 60% for the transportation sector which is one of the major emitters (over 70% of total anthropogenic emissions). A conservative estimate is that emissions will stagnate in the other sectors.

5. Policies and measures that increase greenhouse gas emissions

5.1. Energy sector

Since the middle 70s, France has been seriously concerned with reducing its reliance on fossil energy and has therefore developed an overall public strategy in this direction. As of today, very few policies have a tendency to increase greenhouse gases and will be discontinued in the near future or completed with corrective measures aimed at mitigating the negative effects.
Following are more detailed examples:

* coal policy:

French coal production has received subsidies aimed at compensating excess production costs of French coal compared with imported coal. The first consequence of this policy is that French coal replaces imported coal; however this policy does not result in an overall increase in coal consumption, it therefore has a negligible impact in terms of CO_2 emissions. Furthermore, "EDF" is also required to purchase a minimum volume of French coal; though this volume is lower than "EDF's" average needs, in the recent past this requirement nevertheless resulted, in the end, in a shift from nuclear electricity to fossil fuel electricity. Considering the prospects of the French coal industry which will be ending all activity by 2005, it is now highly unlikely that this situation been seen again.

* adjustments in low voltage electric rates

The adjustment of low voltage electric rates over the entire French territory masks production and distribution cost discrepancies and results in electricity being sold below its actual costs, on the one hand in isolated regions where electricity is mostly fossil fuel generated (Corsica and the Overseas Districts and Territories), and on the other in low-density rural areas. The objective of this provision is a harmonious regional development through national solidarity towards areas which suffer from "natural" hardships. However, the Public Authorities are aware of certain negative side-effects of this policy and have therefore developed policies and measures aimed a mitigating these, as described in the section on the electricity sector.

5.2 Transportation sector

Road transportation contributes to a large and increasing extent to CO_2 transportation emissions. Obviously, though many public measures required for various reasons within the scope of the transportation policy, also result in reducing the contribution of this sector to the emission of greenhouse gases, a few others have increased the contribution.

The law on air and the rational use of energy of December 30, 1996 clearly identified the responsibility of transportation in air pollution and is aimed at modifying in a direction more favorable to combating the greenhouse effect certain measures taken within the scope of the transportation policy.

Various studies have been conducted in France on the payment by the road transportation sector of the costs generated and that society must incur, and therefore the implicit subsidy this activity receives. Though it seems that overall, transportation activities cover their costs in France, some segments in the road transportation industry probably do not cover all their costs (automobiles in urban areas, freight transportation by road, diesel automobiles). In this respect, the law on air and the rational use of energy of Dec. 30, 96 states that taxes on fossil energy must strive for a balanced treatment between the various types of fuels taking into account objectives that include, in particular, the effect of these taxes on the environment. The law provides that a report on past trends in the taxation of fossil energy which includes a projection of the future choices will be remitted by the government to parliament on a regular basis.

A report by the future studies unit of the Ministry of the Environment (*"Pour une politique soutenable des transports", 1996*) indicates a number of other regulatory or tax provisions that could result in increasing greenhouse gas emissions in France.

IV. ACTIVITIES IMPLEMENTATED JOINTLY

France decided at the end of 1996 to establish a mechanism for instructing and registrating projects that could be considered for joint implementation under the pilot phase (5/CP.1/1996 decision). It is still too early to offer an initial list of activities but the following details should prove useful:

- these activities are open to all countries signatories to the Convention on Climate Change, including Parties not referred to in Annex 1;

- qualification criteria will be applied on a project-by-project basis focusing on a dynamic additive-oriented approach, striving to consider the relative situation of the country benefiting from the project and focusing on the objective of promoting innovative and climate-friendly technologies.

- the institutional mechanism chosen by France associates scientific and technical skills and skills in the investigation of investment projects in other countries;

- joint implementation, in its pilot phase, is seen as a very efficient means of mobilizing the private sector on the stakes of the Climate Convention and the risks of climate change.

V. PROJECTIONS AND ESTIMATES OF THE EFFECTS OF MEASURES

1. CO_2 emissions

1.1. CO_2 energy consumption emissions

France periodically launches, around every five years, a major prospective study on the energy sector. This study is conducted under the aegis of the French Planning Commission and its purpose it to confront all opinions expressed by the ministerial sectors, the major energy operators, non-profit groups and experts... The administrative departments rely to a large extent on the conclusions of these prospective groups to draft its own energy provisions, which are a prerequisite for generating forecasts of CO_2 emissions.

The prospective group "Energy 2010-2020" was launched mid-1996 and its conclusions are due in early 1998, whereas the previous study designated "Energy 2010" was completed in 1991. The elements presented in the First National Communication of France relied on the study, which was summarily updated in order take into account some recent trends.

Elements presents here are based on quantitative data produced up to now by the group "Energy 2010-2020"; these are therefore preliminary results, synthesizing the best information available at this time, however it is subject to change in light of studies that are being pursued during 1997. If need be, France may present an updated version of its emission projections in early 1998, based on the final conclusions of the "Energy 2010-2020" group.

The "Energy 2010-2020" group is implementing a "hybrid" strategy, based on the French energy sector models as well as on precise sectoral information in combination with expert opinions.

More specifically, the group's thinking is based on simulations carried out with the following models:

* the "DIVA" model, which for a given growth rate of the French economy, gives a coherent vision of the allocation of growth by activity sector, at a rather precise level.
* the technical-economic "MEDEE" model, that simulates end-user French energy demand trends in a highly disaggregated format,
* the "MIDAS" model on the partial equilibrium of the energy sector,
* more specific models such as that of he French Petroleum Institute describing the European refinery sector, or the "EDF" model describing the French electric production sector.

The assumptions made regarding the main variables used in the projection study are indicated in the **table below.**

Values of the main variables used in the projection study

	1990	1994	2000	2010	2020
World oil price (US$90 /barrel)	23	14	17	24	24
national energy price (index in inflation-adjusted francs) (*)					
* electricity	100	94	90	90	90
* combustible fuel	100	95	98	100	100
* fuels	100	97	102	109	110
Commercial GDP (GF 80)					
* agriculture	149	142	155	180	209
* industry	1071	1042	1142	1371	1639
* commercial	1676	1752	2068	2673	3455
* total	2896	2936	3365	4224	5303
Population (millions)	56.6	57.8	59.4	61.7	63.4
New passenger car consumption (index) (*)	100	100	98	97	96
Heavy truck specific consumption (index) (*)	100	100	100	100	100
Passenger car traffic (GVkm/year †)	325		381	452	508
Heavy truck traffic (Gt.km/year)	177	-	216	284	373
* including transit	23	-	37	58	90
New housing construction (thousands/year)	280	270	270	240	220
Trends in the commercial sector buildings (millions m^2)	690 (year 1992)	-	766	875	1000
End-user energy demand (MMTOE/year) (*)					
* combustible fuel	117	-	133	148	169
* electricity	71	-	88	102.5	115

(*) scenario "without measures" *(†) Giga-vehicles*

Population growth is continuing at a rate close to 0.4% /year by 2020, with a continued drop in average family size.

Economic growth for the 1994/2000 period is estimated at 2.3% /year, with a continued trend in the increase of the commercial sector of the French economy.

The energy context is assumed to feature a slow growth in the international oil price. The price of gas is presumed indexed on the price of oil, even though other trends are entirely possible (for example, the emergence of a gas "bubble" in the European area). In the reference scenario, we do not predict an increase in the taxation of energy products, because taxes on energy are already high in France, when compared to the situation in other industrialized countries.

According to the scenario "without measures", a noticeable increase in energy consumption is observed, fueled by economic growth, in spite of an improvement in global energy efficiency. Electric consumption rises faster than end-user energy demand, and the share of natural gas increases within the "fossil energy" subgroup. Therefore as long as the nuclear industry continues to dominate the French electric power production sector, the rate of increase in emissions of CO_2 can be expected to grow at a slower rate than energy consumption.

In the electricity sector, an overestimation of the growth of electric consumption in the early 80s led to an excess construction of nuclear plants, this excess should be absorbed over the next projection period. Taking into account the increased on-line availability of nuclear plants since 1992, it is now estimated that this absorption should be completed by 2007. Nuclear plants will be gradually redirected to base-load production, mid-load production being covered by the reopening of fossil-fuel fired power plants, which are more profitable economically for mid-load production. Therefore a rise in CO_2 emissions should take place in the electricity sector between 1995 and 2010, in theory more quickly than the increase in electric consumption.

Beyond then, a relevant question may be asked as to the replacement of existing nuclear plants since this would have major consequences in terms of CO_2 emissions. In a context of increased competition of the European electric utilities, relative competition between production modes seems to be a determining factor in the future composition of the electric production units. The study *"Coûts de référence de la production électrique"*, carried out in 1997 for the Ministry of Industry, shows that though nuclear power remains a solid choice for basic electric production, combined-cycle gas plants may give strong competition to the nuclear sector, in particular if the price of gas remains at a low level for a long time. A this stage, considering the uncertainties on the life-expectancy of existing nuclear plants and the future trend in the price of gas, it was considered preferable to assess the CO_2 emissions in the electric sector by 2020 according to two very different assumptions:

- the first is based on continued competitiveness of the nuclear plants in producing base-load electricity and on an average life-expectancy for existing nuclear plants limited to 40 years.
- the second is based on combined-cycle gas power plants becoming the most economical solution for generating base-load electricity by 2020 and on an average life-expectancy for existing nuclear plants be limited to 30 years.

The results included in the table below confirm the stakes at play with changes in the composition of the electric production pool by 2020: the CO_2 emission differential between the two scenarios considered is estimated at 26 MMTC/year, i.e., around one quarter of total CO_2 emissions by France in 1990.

CO_2 emissions in the refining sector will increase over the 1990/2020 period, mostly because of changes in automotive fuel specifications, which cause an increase in energy consumption in the refineries.

As for energy consuming sectors, strong energy consumption growth will be observed in the transportation sector, with passengers (because of the increase in disposable household income), as well with freight, in particular because of an increase in intra-European trade. The growth of the commercial sector will lead to a sizable increase in specific electric consumption, its impact in terms of CO_2 emissions should, however, remain low in the French context at least until 2010. The domestic and industrial sectors will generate moderate growth in CO_2 emissions past decisions improving energy efficiency (thermal regulations, investments in energy saving) continue to produce effects and compensate for part of the growth in activities.

Overall, energy consumption will increase respectively by 17%, 33% and 50 % over the 1990/2000, 1990/2010 and 1990/2020 periods, whereas the increase in energy related CO_2 emissions respectively reach 4% and 22% over the 1990/2000 and 1990/2010. In 2020, CO_2

emissions should be 40 to 67% higher than the 1990 reference, depending on the type of electric energy production.

According to the scenario "with measures", increases in CO_2 emissions will be significantly reduced; taking into account the measures described earlier in the report these should enable maintaining emissions in the year 2000 at their 1990 levels, and limiting the increase respectively at 9% and within a bracket of 21 to 47% over the 1990/2010 and 1990/2020 periods. The global impact to the measures can be immediately inferred: it is respectively equal to 5.2, 13.1 and 20.8 MMTC/year in 2000, 2010 and 2020.

Projection of CO_2 energy emissions
(Scenario "without measures")

MMTC / year	*1990 (observed)*	*1995 (observed)*	2000	2010	2020
Combustible fuel consumption: Energy (production and processing)	*15.4*	*12.5*	12.3	19.8	24 / 50.3
Combustible fuel consumption: Industry	*23.2*	*21.6*	20.9	22	23.4
Combustible fuel consumption: Transportation	*31.4*	*34.1*	38.6	45.7	56
Combustible fuel consumption: Residential	*18.7*	*18.4*	19.9	20.7	21.6
Combustible fuel consumption: Commercial	*7.6*	*7.5*	8.5	9.4	11
Combustible fuel consumption: Miscellaneous	*2.3*	*2.3*	2.4	2.4	2.4
Combustible fuel consumption: TOTAL	*98.6*	*96.4*	102.6	120.1	138.5 / 164.8

(Continental France, excluding international bunker fuels)

Projection of CO_2 energy emissions
(Scenario "with measures")

MMTC / year	*1990 (observed)*	*1995 (observed)*	2000	2010	2020
Combustible fuel consumption: Energy (production and processing)	*15.4*	*12.5*	10.4	16.9	19.8 / 46.1
Combustible fuel consumption: Industry	*23.2*	*21.6*	19.8	20.6	22
Combustible fuel consumption: Transportation	*31.4*	*34.1*	37.4	39.3	45.4
Combustible fuel consumption: Residential	*18.7*	*18.4*	19.4	19.6	19.7
Combustible fuel consumption: Commercial	*7.6*	*7.5*	7.9	8.8	9.8
Combustible fuel consumption: Miscellaneous	*2.3*	*2.3*	2.4	2.4	2.4
Combustible fuel consumption: TOTAL	*98.6*	*96.4*	97.2	107.6	119 / 145.3

(Continental France, excluding international bunker fuels)

Emissions projections in the energy consumption sectors presented in this section are inferred from the projection in end-user energy demand supplied by the MEDEE model; these are based on trends computed from a (1992) reference level estimated by the model, which represents a slightly different sectoral allocation than that observed in 1992. To correct this bias, previsions for 2000, 2010 and 2020 were obtained by applying to the sectoral values observed in 1992, the relative variations 1992/2000, 1992/2010 and 1992/2020 computed with the help of MEDEE.

Moreover, models of the French energy system are based on official energy statistics, that are adjusted in particular for climate variations; data for 1990 and 1995, included in the tables below, in congruence with this approach, therefore differ slightly from inventory data supplied in the previous section of the report.

The trends decribed above only concern continental France. No long-term energy forecasts are available as of now for the French Overseas Districts and Territories. For the 1990/1995 period, CO_2 energy emissions were estimated within the scope of studies undertaken on greenhouse gas emission inventories. An increase in these emissions near 4.7% per year was observed over the same period. At this stage, the reference scenario chosen is a persistence of the trend until 2000. The « with measures » scenario is obtained by inferring the impact of the measures described earlier in the report.

It is not possible at this stage to indicate reliable data for the "DOM/TOMs" for the period beyond 2000.

Finally, mention should be made that at this stage the projections presented above are highly dependent on the assumptions made regarding all key parameters: economic growth, import costs of various fossil energies, ... the margin of uncertainty of CO_2 emissions by France in 2000, 2010 or 2020, remains high, for a given emissions control policy.

More specifically economic studies suggest that potential growth for the French economy for the period 1994/2015 would be 2.6 %/year as the best guess; energy efficiency improvement observed during the 1984/1996 period was about 0.5% / year, while the sectoral assumptions made in the « without measures » scenario lead to an energy efficiency improvement of 0.65% / year for the 1990/2020 period.
Based on the latter assumptions with respect to GDP (2.6%/year) and energy efficiency improvement (0.5%/year), which can also be considered as realistic taking into account the slow increase in projections of energy prices, CO2 energy related emissions of France would be 4.5, 9.5 and 15% higher than the previously indicated levels for the years 2000, 2010 and 2020.

The following table summarizes the results of the CO2 energy emission projections; two scenarios are finally presented, the « so called » low case assumption which is the projection described in detail in this section and the « so called » high case assumption which is based on the last assumptions about GDP (2.6%/year) and energy efficiency improvement (0.5%/year). The two figures for 2020 presented in each case correspond to the two options with respect to the electricity generating pool mentioned before.

Impact of the measures in the energy sector

MMTC/an	*1990 (observed)*	*1995 (observed)*	2000	2010	2020
« without measures » scenario	100.9	-			
* low case assumption			106.2	120.1	138.5 / 164.8
* high case assumption			111.0	131.5	159.3 / 189.5
« with measures » scenario	100.9	99.4			
* low case assumption			100.8	107.6	119.0/145.3
* high case assumption			105.8	118.4	138.5/168.7
Impact of the measures	-	-	5.2	13.1	20.8

Total for France for the years 1990,1995 and 2000
Continental France for the years 2010 and 2020

1.2. Non-energy related CO_2 emissions

Non-energy consumption related CO_2 emissions include:
- emissions from industrial processes;
- emissions linked to inorganic waste incineration;
- emissions (and removals) linked to land-use changes and forestry.

Projections of industrial processes rely directly on projections of emitting activities chosen in the previously mentioned projection study of energy demand.

Emissions linked to inorganic waste incineration are determined by the trend in waste production by 2020[1] and waste composition, as well as the regulatory context influencing the disposal method (see section on "policies and measures"). In the scenario "without measures", the assumption is that the share of waste being incinerated will remain constant over the 1990/2020 period.

The trend in emissions and removals linked to changes in land-use and forestry were estimated for continental France only; it is hard to provide figures for the trend in the "DOM/TOM", even if the experts believe that there will be no significant changes by 2000/2010.

The trend in production of French forests (continental France), presented below, was extrapolated from trends observed in the past. A more sophisticated methodology is being developed; it should enable taking better account of the various factors, that influence forest biological production; for example:

- Today French forests are in a phase of increased annual production; however, beyond a certain phase of accumulation, because of tree-aging, production should drop; however predicting when this drop will take place is not easy because the "mature" stage could be closer or farther away depending on future environmental conditions (an increase in the greenhouse effect in particular),
- Several trends in forestry management (shorter planting intervals, increased frequency of release cutting) should contribute to increasing production; other factors that could strengthen these trends, such as the substitution of local species with more productive and/or genetically improved species, depend on changes in forestry management practices (in particular, it is hard to estimate the potential consequences of the current "sustainable forest management" debate),
- A one-third increase in CO_2 in the air for over a century is probably the partial cause of increased forestry production, over the same period, in a large area in Europe. This consequence should persist, but we do not know its intensity; moreover, it could be dampened by the effects of a reduction in emissions of nitrogen pollutants (automotive and agricultural-source pollution), which stimulate tree growth; finally, long-term production trends also depend on rainfall trends, which are still highly unknown under the current state of knowledge (thus, more severe and greater drought frequencies could challenge this trend).

Nevertheless, the experts estimate that a modification of the trend is highly unlikely by 2010, but are careful not state their opinion as to the outcome by 2020 without a more precise description of forest response under the influence of the various parameters.

[1] A 35% increase between 1990/2020 is anticipated, i.e., a sizable drop compared with trends observed over the 1960/1990 period.

Projections of non-energy related CO_2 emissions

MMTC / year	1990	1995	2000	2010	2020
Industrial processes (single scenario)	4.5	4.3	3.9	4	4.1
Waste incineration (without measures)	*0.5*	-	*0.6*	*0.65*	*0.7*
Waste incineration (with measures)	0.5	1	1.7	3.1	3.5
Changes in land use and forestry (single scenario) (*)	-9.6	-11.6	-14.6	-17.7	-
TOTAL (without measures)	*-4.6*	-	*-10.1*	*-13*	-
TOTAL (*with measures*)	-4.6	-6.3	-9	-10.6	-

(*) Projections are limited to the « woods and forests » and « poplar groves » sub-categories and to changes in agricultural land use as described in section III 1.5 and III 1.6 on policies and measures.

2. CH_4 emissions

The projections are not comprehensive since some categories or sectors of the inventories are ignored; they nevertheless cover the main emitting categories and are based on the information provided in the section on policies and measures. In some sectors, a single scenario is offered.

The trend in the agricultural sector, in particular in the livestock farming sector, beyond the year 2000, will be crucially dependent on changes in the Common Agricultural Policy and the conclusions of the next round of multilateral negotiations. However, in all likelihood emissions of CH_4 will change very little beyond 2000 if action-oriented prevention policies are not implemented in this sector, these have not been decided on at this time; it will therefore be assumed that CH_4 agricultural emissions will remain constant over the 2000/2020 period.

In the waste sector, two scenarios are presented: the first ("without measures") presupposes the persistence of current waste[1] disposal practices; the second ("with measures") presupposes that waste disposal practices take into account the elements indicated in the section on policies and measures.

Regarding fugitive emissions of combustible fuels, a scenario "without measures" is based on the assumption that the leakage rate in the natural gas distribution network remains constant — at the level observed in 1990 — over the 1990/2020 period. The scenario "with measures" is described in the section on policies and measures.

Finally, only a single scenario of the trend in coal mine emissions is presented.

[1] More precisely, the assumption is that the proportion of landfilled waste, on the one hand, and the portion of recovered landfill gas on the other, remain the same as in 1990 over the 1990/2020 period.

Projections of CH_4 emissions

MMTC CH_4 / year	1990	1995	2000	2010	2020
Agriculture (single scenario)	1.52	1.44	1.52	1.52	1.52
Landfill emissions (without measures)	*0.46*	-	*0.56*	*0.68*	*0.76*
Landfill emissions (with measures)	0.46	0.56	0.40	0.10	0.02
Fugitive combustible fuel emissions (without measures)	*0.11*	-	*0.13*	*0.14*	*0.15*
Fugitive combustible fuel emissions (with measures)	0.11	0.085	0.085	0.10	0.115
Coal mine emissions (single scenario)	0.2	0.2	0.05	0.015	0
TOTAL (sans measures)	*2.26*	-	*2.30*	*2.43*	*2.54*
TOTAL (single scenario)	2.26	2.26	2.11	1.76	1.67

MMTCE / year	1990	1995	2000	2010	2020
TOTAL (without measures)	*12.9*	-	*13.2*	*13.9*	*14.6*
TOTAL (with measures)	12.9	12.9	12	10.1	9.6

GWP over 100 years, IPCC 1995

3. N_2O emissions

The projections are not comprehensive since some categories or sectors of the inventories are ignored; they nevertheless cover the main emitting categories and are based on the information provided in the section on policies and measures. In some sectors, a single scenario is offered.

Projections of N_2O emissions in the transportation sector and industry (limited to industrial processes) are based respectively on the projections in road traffic trends (taking into account different types of engines and the rate of introduction of catalytic converters) and the relevant industrial activities, explained in the projection study on energy demand mentioned earlier. The scenario “without measures” for industrial processes keeps the level of emissions constant per product unit observed in 1990, whereas the scenario “with measures”, refers to impacts described in the section on policies and measures.

Moreover, the assumption was that N_2O emissions in agriculture remained constant over the 2000/2020 period. Relative ignorance of the causes of non-point source farmland N_2O emissions makes detailed forecasts difficult; however, the belief is that issues of non-point

source nitrate water pollution could lead farmers to control nitrogen fertilization on a sustainable basis.

Projections N_2O emissions

1000t N_2O / year	1990	1995	2000	2010	2020
Agriculture (single scenario)	60	55	52	52	52
Industrial processes (without measures)	*90*	*77*	*77*	*112*	*162*
Industrial processes (with measures)	90	77	14	21	30
Transportation (single scenario)	4	6.6	14	18	19
TOTAL (without measures)	*154*	-	*143*	*182*	*233*
TOTAL (with measures)	154	138.6	80.3	90.8	101.1

MMTCE / year	1990	1995	2000	2010	2020
TOTAL (without measures)	*13.4*	-	*12.5*	*15.9*	*20.4*
TOTAL (with measures)	13.4	12.1	7	7.9	8.8

GWP over 100 years, IPCC 1995

4. HFC, PFC and SF_6 emissions

It was not feasible, within the scope of this Communication, to furnish projections regarding HFC, PFC and SF_6 emissions.

VI. ASSESSING VULNERABILITY AND ADAPTATION MEASURES

Since 1993, France has been expanding research and studies on the regional effects of climate change, the target objective being:

- to construct plausible scenarios climate characteristics trends in France (including in the Overseas Districts and Territories) over the next century under the influence of an increase in the anthropogenic greenhouse effect caused for example by a doubling of CO_2 in the atmosphere compared to the pre-industrial era;

- assess the likely consequences of these changes on water resources, agriculture, forestry, coastal areas, ..., as well as their direct and indirect socioeconomic consequences;

- assess the vulnerability of the most exposed regions and suggest possible adaptation strategies.

As of now, the following are the most important results of this research:

- Numeric simulations carried out with high resolution space-time climate models first validated on the current climate in Western Europe, indicate that, in the event of a doubling in atmospheric CO_2 around the year 2060, France's temperature could rise by 2°C — more in the summer and the South of the country. This warming would cause an increase in winter rainfall by around 20% and a decrease in summer rainfall of around 15%; these trends would be more pronounced in the South than in the North. The consequence would be increased flooding in winter and spring and a drop in soil humidity in the summer and fall resulting in increased water stress for crops (corn, tobacco, sunflower,...) and forest trees (umbrella pine, beech, common oak,...) that are the most exposed to drought.

- The decrease in available soil-water during the active growth season in the summer would lead to major wilting and losses of agricultural and to a greater extent forestry productions, in particular in the southern regions. For example, intensive corn crops and umbrella pines in the Landes could be threatened, the Mediterranean forest would risk serious damage due to increased drought periods and more frequent forest-fires, ... Dendroclimate studies (links between tree-rings and climate) show that beech forests in plains and medium-altitudes in Lorraine are also highly exposed to water stress, just as Scotch firs are in the mountain chain "l'Etoile" (in the Southern Alps). Forestry dieback caused by drought could worsen insect infestations or pathogenic fungus (bark beetles, armillaria, ...).

- Warming would cause the snow cover to recess in the Alps and Pyrenees, which would have major socioeconomic consequences (decrease in snow related tourism activities). Increased snow (and glaciers) melting in spring would increase the risk of avalanches in the mountain and record floods in the valleys: flows of the Rhone river and the Garonne would be affected.

- In general, a more intense water cycle would increase the risk of floods in winter and spring, as well as the length of low-water periods (from June/July to October/November). This would result in a drop in nuclear plant and water dam electric production.

- In the event of a rise by 30 cm in the sea-level along the coast of continental France and the "DOM-TOM", several consequences can be feared: increased submersion of low-lying coasts, in particular delta areas (Rhone delta,...), of lagoon shorelines, coastal swamps, coral reefs (that will suffer from warming: cf. coral bleaching in Polynesia); increased cliff and beach erosion ; increased salinity of estuaries; diminishing fresh groundwater levels. These events could worsen if, as models appear to show, cases of "surges" (brutal and temporary increases in sea levels) became more frequent than today because of the anticipated increased strength of storms and hurricanes.

In order to deal with these dangers, the relevant departments and public authorities are starting implementing precautionary measures, such as improved water resources management, limiting intensive farming, decreasing tree-density in forests exposed to water stress, choosing drought resistant forest species for new plantings in hazardous areas, avoiding the planting of forestry species on the outer edge of their range.

VII. INTERNATIONAL COOPERATION AND FINANCIAL MECHANISMS

Prevention of the greenhouse effect demands a strengthening of international cooperation and solidarity. We will discuss separately France's cooperation with developing countries and countries with economies in transition to market economies.

1. Cooperation with developing countries

International cooperation is one of the major issues for improving prevention of the greenhouse effect.

Therefore, France has focused its policy on two objectives:

- pursuing an active development assistance policy,
- supporting additional and specific mechanisms aimed at combating the greenhouse effect.

1.1. French development assistance

Financing by industrialised countries should be encouraged for actions specifically aimed at reducing greenhouse gases of developing countries, but it is certainly just as important to strive to accelerate the development process of these countries: indeed, demographic trends are, over the very long-term, the major factor of future emissions of greenhouse gases and though development will not be sufficient to control population growth, it represents, nevertheless a necessary condition thereof.

France is one of the most generous countries in terms of official development assistance (ODA). In 1995 it became the second donor country in the amount of assistance furnished, at 8.4 billion dollars. France is ranked first among the 7 most industrialized nations (G7) in percentage of Gross Domestic Product (GDP) allocated to official assistance. France spent 0.55% of its GDP on its ODA effort in 1995, the average for OECD countries was 0.27%.

The development assistance policy conducted by France in 1995 represented a forerunner of the general stance adopted by the G7 in Lyon in 1996. French policy is aimed at integrating the poorest countries into world trade and bringing together the conditions for sustainable and socially acceptable economic development with the injection of public and private funds.

France's bilateral cooperation action is carried out by the relevant ministries and public financial corporations such as the French Development Bank ("CFD"), research organizations such as the "CIRAD", "ORSTOM" and the French Environment and Energy Control Agency ("ADEME"), as well as some local communities.

1.1.1. Bilateral assistance

Net contributions of France under bilateral assistance reached 32 billion French francs in 1995, i.e., the equivalent of 76% of its total ODA.

Public assistance is focused in particular on crucial sectors such as health and education, basic infrastructures and water management. It must also permit strengthening the role of women role in development countries.

The creation in developing countries of a dynamic and competitive private sector is also encouraged, in order to ensure over the long term the existence of a productive sector, guaranteeing sustainable and balanced growth.

Strategic priorities of French assistance are built around combating poverty, in particular in the least developed countries, in backing the private sector, in promoting projects focused on women, on developing the institutional capacities and on environmental protection.

In the field of the environment and sustainable development, France's action is guided by the principles expressed in 1992 at the Rio Summit, viewing the evolution of our planet within a sustainable development perspective. Within this framework, social and economic development must be linked with long-term management of the local and global environment, with the goal of avoiding irreversible actions. These concerns find especially suitable applications in developing countries. In Africa, in particular, contrarily to what is taking place in our industrialized societies, natural resources (underground, soil, plants, continental and maritime waters) represent most of the productive base. Therefore, the stakes, simultaneously with a diversification of their economies, are to promote forms of resource management that ensure lasting resources.

Following this reasoning, environmental preservation can only be sustainably ensured if it contributes to a greater extent to the vital needs of the populations or the economic actors (businesses, states...).

This action is aimed in particular at the following objectives:

- supporting the sustainable development of partner countries in the sectors of activity where the long term stakes are particularly important, for example in situations where human action can lead to irreversible degradation,

- support consideration for environmental criteria in bi- and multilateral development assistance projects, and the implementation of a sectoral environmental policy within French and international development assistance institutions.

All the instruments of French assistance have gradually acquired the means to carry out environmental assessments; the proportion of projects completed in the environmental sectors is increasing.

Drinking water supply is a priority because it enables the long term control of water resources and sustainably managed production, water treatment and distribution, by involving the populations increasingly, in particular in the rural areas. The same is true for the sustainable development of regional areas and natural resources which form a major part of the objectives of French assistance i.e., sustainable regional planning and development of these areas. Waste-water sanitation, industrial decontamination and safety, improvement in living environment, public health and waste management are also concerned.

For example, in 1995, environmental operations programmed by the “CFD” (French Development Bank) in Foreign states represented 1.65 billion French francs, i.e., 28% of the programs. In 1995, after three years of testing, an environmental mechanism was integrated into the project cycle at the “CFD”.

Actions of the French Development Bank ("CFD")

The French Development Bank is a specialized financial institution, its capital is entirely owned by the state. It contributes, through long-term loans and subsidies, to economic and social development in 60 countries in Africa, the Indian Ocean, the Caribbean, the South Pacific and Asia. It finances public or private productive investments in all sectors of the economy. It also finances, for the French state, structural adjustment programs. Finally, it conducts technical assistance and training programs for managers.

In 1996, the "CFD's" foreign commitments reached 8 billion French francs, including 4.9 billion FF for project assistance. Out of overall allocated project funds, 20% were subsidies, 55% were soft or very soft loans and 25% were market or near market-term loans.

"CFD" commitments, considered as financing directly targeted to environment aspects, show for 1996 a total amount of 0.85 billion FF, i.e. 17% of the commitments to such environmental projects. Over half of these projects concern drinking-water and sanitation, which remains a priority area for countries located in the field of action of the "CFD".

A large number of projects, sometimes not assigned to the environmentally targeted project category, have a positive impact on climate warming.
Over the 1995/1996 period, examples were:
- 5 rural development projects, with agricultural production intensification and soil fertility management, thereby limiting the use of slash-and-burn cultivation, possibly introducing agroforestry;
- 4 sustainable management projects on forestry perimeters and 1 reforestation project,
- 4 hydroelectric projects, 2 windpower electricity generating projects, 2 photovoltaic projects and 1 thermal solar project (drying in the agrofoods industry),
- 1 paper mill restoration project, including an energy control aspect,
- 4 investment projects in the rail transportation sector, allowing for maintaining or developing the share of this transportation mode which emits less greenhouse gas.

The commitments for these actions reached 500 million French francs over the 1995/1996 period.

1.1.2. Multilateral assistance

France allocated 10 billion French francs in financial resources in 1995 under multilateral assistance.

This assistance has been mainly channeled through the United Nations, the European Commission and international financial institutions.

France is participating in all the multilateral development assistance mechanisms. France in all international forums responsible for multilateral instruments shows the same

determination to grant multilateral assistance absolutely essential financial, institutional and management means for conducting assistance efficiently.

In particular, France is attached to the principle of balanced burden sharing, the cornerstone of the multilateral system; France backs establishing enough financial resources for international financial institutions, the implementation of institutional reforms when needed, and that these institutions define operational strategies in conformity with the objectives of sustainable development, focusing efforts on the least developed countries, and combating poverty and respect for the environment.

With respect to environmental protection, France supports a strengthening of the activities and financing of multilateral organizations directed towards sustainable management of natural resources as well as better integration of environmental concerns at the planning stage of development projects.

1.2. French assistance for global environmental protection and climate change prevention

France initiated the establishment of the Global Environment Facility which finances incremental costs in development projects related to global environmental preservation. The facility intervenes in four sectors: combating the greenhouse effect, biodiversity preservation, the protection of international waters and protection of the ozone layer.

Established on a pilot basis in 1990 and restructured in 1994, the GEF was funded with 2 billion dollars for the 1994-1997 period.

France, with 807 MFF, is the fourth contributor to the GEF.

As of today, 47% of the GEF's funding has financed projects concerning the greenhouse effect.

France established in 1994, in addition to its funding of the GEF, a French Global Environment Facility (FGEF), funded with 440 MFF, over the same period. The FGEF has 44 projects, reflecting a programming capability of 202 MFF.

51% of the financing is, as of today, directed towards the greenhouse effect.

Distribution of the 21 "greenhouse effect" projects currently under review or being implement is the following:

* Sub-Saharan Africa 9
* Maghreb 3
* Asia / South America 5
* Eastern Europe 3
* Global 1

By implementation sector, "energy/electricity" and "forests" are the most advanced (with respectively 7 and 6 projects), followed by housing and urban development (domestic waste).

This funding complements measures, assistance and cooperation projects conducted by French assistance partners, with a greenhouse effect prevention facet.

In the energy sector, French assistance is applied to situations where renewable energy and energy efficiency now represent an economic alternative. For example: rural and decentralized electrification (photovoltaics in particular), bioclimate construction, domestic waste-to-energy (methane use), and biomass fuels in certain specific contexts.

The French Global Environment Facility (FGEF) and climate change

Reflecting its implication in the field of climate change in developing countries and countries in transition, France has established a bilateral financial instrument specifically devoted to the global environment

The FGEF complements the French contribution to the GEF and intervenes according to the same guidelines as the GEF. Half the projects concern the climate area.

The FGEF's priorities are the following:

- priority to the African continent , considering the particular needs of the region and the overall geographic priorities of French foreign assistance;

- focus on the reproducibility of the projects

Considering the obviously limited impact a project has on the global environment, the directors of the FGEF and its scientific committee focus on projects that have a high reproducible potential and can be extended to other sites or other countries.
This way, the FGEF strives to play an active role in promoting and helping innovations.

- importance given to the objective of socioeconomic development

The FGEF's purpose is to finance incremental costs linked to global environmental protection in development projects. It therefore fits in directly with a development objective, with which it must respond and comply with.

- focus on project innovation

The FGEF intervenes to encourage the spread of innovation benefiting global environmental protection. This innovation can be scientific, technical, technological or institutional. It implies most often direct and indirect costs that justify a special financial effort. This effort is therefore aimed at fostering real dynamic learning.

These priorities directly and aptly apply to the field of climate change, where the scientific committee of the FGEF focuses on the three following criteria: dynamic learning of development synergy — global environment; social and institutional experimentation of the conditions for appropriating generally mature techniques; search for reproducible techniques and appropriation methods.

New and additional bilateral financial contributions related to the implementation of the Convention (millions of US Dollars)

		Secteurs			
		Energy	Forests	Waste management	Industry
1994	Côte d'Ivoire		1		
	Vanuatu	0,2			
	Sao Tomé	0,4			
	Cap Verde	1			
	Brasil / Zaïre/Indonésia		0,2		
1995	Gabon		1,2		
	India			1	
	Mali		1		
	Roumanie	1			
	Tunisie	2			
	Burkina Faso	0,3			
1996	Liban	1,2			
	Brasil	2	2		
	Russia			1,2	
	China	2		2	
	Slovaquia	2			
	Côte d'Ivoire	1,5			
1997	Maurice	1			
	Indonésia	2			
	Mauritanie	1			
	China	2			1
	Europe Centrale				2
	Maroc		2		
TOTAL	34,2	19,6	7,4	4,2	3

1.3. Scientific cooperation

Research contributions amount to 2.5 billion French francs per year, spending is mostly devoted to the financing of specialized research organizations such as “CIRAD” and “ORSTOM”.

<u>* The French Center for International Cooperation for Agricultural Science and Development (“CIRAD”)</u>

The “CIRAD” is a specialized scientific organization for agriculture in tropical and sub-tropical regions. Its budget is around 1 billion French francs, two-thirds are public subsidies, and it employs 1,800 people, nearly 40% of which reside abroad, in around fifty developing countries.

Its studies concerning annual crops and forestry (around 200 MFF in public funding) contribute to a large extent to the prevention of climate change by ensuring the preservation and growth of carbon sequestration contained in soils and in the forestry biomass of tropical countries.

These studies are aimed in particular at:

- settling farmers, in particular in Western Africa and Madagascar;

- forestry development, protection and use in order to achieve sustainable timber production;

- preserving or restoring soil fertility.

More selective studies (around 10 MFF) are targeted on prevention of the greenhouse effect:

- producing liquid fuels from vegetable oils and alcohol

- energy use of agricultural and agribusiness by-products (combustion fuel, pyrolysis, gasification, methane fermentation)

- research on determining factors in greenhouse gas emissions in tropical ecosystems, in particular on the role of economic policies affecting the agricultural sector.

* The Overseas Territories Scientific Research Agency ("ORSTOM")

The "ORSTOM" is a scientific and technical public corporation leading research on inter-tropical environments: land and ocean ecosystems, agricultural systems, human societies, ... It has a budget of 1 billion French francs, 95% are public subsidies, and it employs 820 scientists located in facilities in around forty countries.

The "ORSTOM's" programs that can be linked to preventing the greenhouse effect concern:

- studying methane fermentation of agribusiness waste, with the objective of both producing energy and controlling local pollution;

- soil reactions linked with various crop systems for the purpose of preserving fertility and even their restoration. This includes biological reactions of soils, uptake of organic matter and methane emissions, in particular in rice paddies;

- the dynamics of agricultural production systems. Analyses and understanding of production systems under all their aspects: biophysical, technical, economic and social, is one of the keys to sustainable development, and crucial for decision-making of those in charge of development options. The "ORSTOM's" studies concern Africa and Latin America;

- the study of forestry ecosystems on the one hand, arid environments on the other. The approach is based on preserving ecosystems and their diversity with the prospect of controllable exploitation (for example programs of agro-forestry and set-aside management).

- the study of the role that tropical oceans may play in increasing carbon dioxide in the atmosphere; assessment of the biological pump and ocean-atmosphere transfers.

The various research studies mobilize around 150 scientist and represent a public financial contribution of close to 200 million French francs a year.

* The French Environment and Energy Management Agency ("ADEME")

The "ADEME" contributes to the national technical, scientific and institutional cooperation effort with Southern countries.

Since 1992, it main issue-based programs are:

* decentralized rural electrification: carrying out a pilot program of decentralized rural electrification in Morocco, photovoltaics projects in Tunisia and the development of new concepts within the framework of an "ADEME-EDF" agreement; communication and activities centers (Benin, Burkina Faso, Mali, Chad) and decentralized service companies (Mali, Senegal).

* energy production from lignocellulosic biomass: cofinancing a regional research center in the Ivory Coast, contribution to the European program on cogeneration in Southeast Asia,...

* clean technologies, energy savings in public buildings in West Africa, Central Africa and the Indian Ocean), urban transportation management in Latin America,...

Actions for rational energy use and developing renewable energy in Southern countries benefited, over the 1992-1996 period, from a financial contribution maintained at 4 MFF per year, combining "ADEME's" own funds with specific contributions of its major French institutional partners.

Moreover, France proposed a transfer of knowledge in the energy management and planning area, relying in particular on the experience of "ADEME", which served as a model or catalyst for the establishment of local institutions specifically responsible for these issues (Tunisia, Algeria,...).

Other research organizations play a positive role in preventing the greenhouse effect. The National Agronomic Research Institute and the National School of Rural Engineering for Water and Forests are active in the sector of tropical forests (developing forest plantings that respect the major biological balances). Various teams from the National Center for Scientific Research assist developing countries (Senegal, Ivory Coast, Brazil, Thailand) in drafting national inventories of greenhouse gas emissions and defining national prevention strategies at lesser costs.

Moreover, France is supporting research for controlling desertification through the action of the Sahara and Sahel Observatory.

2. Cooperation with countries in transition to market economies (CEECs and CIS)

The reduction in greenhouse gas emissions is an important consequence of several cooperation actions undertaken with these countries.

2.1. Ensuring nuclear safety in Eastern Europe

The nuclear power furnishes around 15% of electricity production in these countries.

France, in close cooperation with Germany has played a leading role in cooperation led by the international community, over the last four years, supporting the improvement of nuclear safety in the Central and Eastern European Countries and the former USSR, the first objective being to avoid a nuclear accident and to limit the use of fossil energy electric production in the countries.

This cooperation takes place by contributing within organizations (administrative departments and the French Atomic Energy Center ("CEA") and French corporations to thinking and studies carried out by institutions and international organizations (IAEA, NEA, IEA, "RAMG", "WANO", "TPEG") as well for the activities of international consortiums ("ENAC", "CASSIOPEE", "EFCC", "RBMK").

Besides its Community effort, France is making a financial contribution of 360 MFF (for the 1993-1996 period) to the International Fund for Nuclear Safety in Eastern Europe managed by EBRD, and 150 MMF for bilateral cooperation actions, in addition with a voluntary contribution to IAEA and the furnishing of French experts to the Agency.

The bilateral actions conducted by France have focused mostly on three major issues of the multilateral program adopted by the G7 at the Munich Summit in 1992, but also on the nuclear fuel cycle, radiation safety or the strengthening of the structures of the nuclear industry.

Regarding operational safety procedures, the best approach has been on-site assistance and especially, the pairing of French nuclear plants with six relevant countries (Hungary, Czech Republic, Slovakia, Ukraine, Bulgaria and the Russian Federation). These pairings are aimed at increased both the level of safety and the availability of the plants. They allow operators to trade experiences, know-how and technology transfers and conduct training sessions. Other actions contributing to an improvement in operational safety were conducted over the past few years or are underway, such as training for accident management or non-destructive trials (Ukraine) or the videodisk inventory of a plant's major equipment (Slovakia, Ukraine).

Finally, French bilateral cooperation in this field has been strengthened lately by installing compact simulators for operational training at the nuclear plants and with the regulatory safety authorities (Ukraine and Bulgaria).

Improving technical features of the nuclear plants, the second issue in the multilateral plan, is the subject, on the one hand of multilateral agreements on supplying essential materials (agreement with Bulgaria, Lithuania and Russia, under discussion with Ukraine), on the other bilateral agreements for training seminars on technical subjects such as tank radiation exposure analysis (Russia) and the transfer of design computing codes (Russia).

Regarding the strengthening of regulations, it mostly takes the form of general cooperation between the French safety authority, its technical support by the French Institute for Nuclear Safety and Protection and their counterparts in Eastern European countries to which some specific actions are added. These are projects for the installation of compact simulators to be used by the Bulgarian and Ukrainian safety authorities, preliminary safety

analysis studies (Ukraine), as well as regional actions on the adaptation to VVER reactors of the computing codes “Cathare” and “Escadre” and carrying out corresponding training sessions.

Moreover, the nuclear fuel cycle was the subject of several cooperation projects, in particular on cycle strategy (former Czechoslovakia, Ukraine) and on organization and technical procedures at the end of the cycle (former Czechoslovakia)

Finally, bilateral actions were carried out, or have been decided in support of the development of a safety mind-set (Russia, Ukraine), in the area of radiation safety and environmental monitoring (Bielorussia, Russia) and the strengthening of certification and quality organization (Russia).

Anticipated effects:

- to avoid a new accident with serious direct consequences that could consequently slow nuclear development, even where it is designed and operated safely;

- to preserve non CO_2 generating electric production, which is currently offsetting the production of 60 MMTC per year in the relevant countries.

2.2. Energy savings

In all Eastern European Countries, it is estimated that at least 30% in energy savings can be obtained by implementing practices used in the West.

All the actions launched to improve energy efficiency in these countries have three positive consequences:

- restoring the capacity of the CIS to export fossil energy which is its main foreign exchange source

- improving competitiveness of the economies of the countries of Eastern Europe

- reducing their CO_2 emissions.

Many initiatives have been taken in this field.

Actions financed on French funds on a bilateral basis are often a first stage of a mechanism relayed by multilateral financing (World Bank, EBRD, PHARE and TACIS Community programs funded with 1.5 billion ECU).

Two public corporations play a major role in promoting these actions: ADEME and “Gaz de France”

“ADEME’s” actions are focused on:

- institutional backing for countries to define and implement energy management policies and in particular for establishing energy management agencies,

- developing cooperation in higher education, science and technology,

- establishing decentralized cooperation by implementing relations between local authorities in the two countries,

- On-location presentation of French industrial services with expertise in energy control.

"Gas de France" has striven to show the CIS that the best was for gas to be available at a low cost was to save it, this is less costly than exploiting new deposits. For this purpose, "GDF" has carried out energy audits with industrial clients of GAZPROM and in the heating of housing in Moscow; "GDF" is also involved in the operation "Prague Clean City" to define new terms and conditions for saving 25% of the energy need for heating. Finally, the French chemical industry is participating in the offer made by the European Council of Chemical Manufacturers Federation (ECCMF): to carry out free energy audits requested by the chemical industry of countries "in transition".

For these various actions to be really effective, energy consumers in these countries must be made aware of the need for energy control, and in Russia, such awareness requires that fuel prices rise closer to world prices.

2.3. Reducing natural gas leaks

Though the stakes for the greenhouse effect are lesser than for energy savings, active cooperation is developing also in the area of natural gas under the impetus of "GDF" which has been striving since 1991 to convince partners of the efficiency distribution methods using polyethylene networks.

Various demo operations were carried out in Russia and Ukraine (each time on 1 to 3 km of the network) in Moscow, Saint Petersburg, LVOV, JITOMIR.

A partnership between MOSGAZ and "GDF" is preparing the establishment in Moscow of a Technical Training Center for polyethylene gas distribution.

Finally a production plant for polyethylene pipes has been launched in partnership with a Russian company and a French one.

Other operations concern the gas transportation network (audit of a 500 km section, cathodic protection...)

VIII. FRENCH CONTRIBUTION TO RESEARCH ON GLOBAL CLIMATE CHANGE

1. Global climate change

Research at the international level initially focused on physical, chemical and biological aspects enabling the study of human-induced climate trends, by establishing the World Climate Research Program (WCRP) followed by the International Geosphere-Biosphere Program (IGBP). In 1995 the ICSU decided to sponsor with the ISSC the International Program on the Human Dimensions of Global Change (IPDH) which will redefine it objectives.

French research organizations followed the international model, but in order to stress the fact that climate change and global environment is the result of multiple interactions of elements of system Earth, these were regrouped within a single program: the French IGBP which included national participation in WCRP and IGBP. Current changes in this program take into account international changes and in its new composition, the Scientific Committee of the new Research Program on Global Change (former IGBP) includes representatives from the social sciences, i.e., covering the 3 major international programs.

All the programs related to the Environment were recently substantially reorganized within the National Center for Scientific Research ("CNRS"). This organization covers aspects of local Environment that do not relate to Global Change.

1.1. The French IGBP

Five national science programs now cover the essential areas of study: atmosphere, ocean and biomass. These are:

- the National Program for the Study of Climate Dynamics ("PNEDC") which covers a large part of the WCRP and the PAGES[1]/IGPB

- of the Ocean Flux Study ("PFO" or JGOFS-France[2]) which is the French component of the JGOFS/IGPB program

- of the National Atmospheric Chemistry Program ("PNCA") which cover tropospheric and stratospheric physiochemistry, e.g., SPARC[3]/WCRP et IGAC[4]/IGBP

- of the National Coastal Oceanographic Program, associated with the National Program "Coral Reef", the French equivalent of LOICZ[5]/IGBP

- of the National Program "*Déterminisme du Recrutement*" which corresponds in part with the GLOBEC[1] program.

[1]Past Global Change
[2]Joint Global Ocean Flux Study
[3]Stratospheric Processes and Their Role in Climate
[4]International Global Atmospheric Chemistry
[5]Land-Ocean Interactions in the Coastal Zone

The following are in addition to these five programs:

- The National Atmosphere and Ocean Medium-Scale Program ("PATOM")

- The National Space Remote-Sensing Program (PNTS),
and, within the scope of the "PIR" Environment, Life, Society of the "CNRS":

- The National Continental Biosphere Program ("PNBC") the French equivalent of the GETC/IGBP,

- the National Program "Biodiversity Dynamics and the Environment" ("PNDBE") for issues within the scope of the International Diversitas program,

Some of these programs are described in Appendix No. 2

The integration of this national effort in international programs is guaranteed by the participation of French scientists in international forums.

Besides these programs, there are several more selective actions, or other programs, some are related to the issues of "global change". For example, the Program on Soil and Erosion Research ("PROSE/INSU"), the Program on Hydrology Research ("PRH/INSU") and the "GIP" (Public interest grouping), "Hydrosystems" and the "GIP" "Ecofor". Some programs conducted by research organizations also deal with the issue of "climate change and the global environment". These research directions are not detailed in the Appendix but they have been taken into account in establishing the overall financial total.

1.2. The program "The economy and society in the face of global change"

This program coordinates the granting of incitement funding (4 MMF in 1994) for structuring research cooperation in economics and sociology in order to organize the prevention of climate change. Its objective is to form in France, on a lasting basis a research environment with skills in this field and capacities to integrate into the work of the international scientific community within the International "IPDH" (International Program on the Human Dimensions)

This program covers the development of research on the socioeconomic aspects of global change related to the increase in the greenhouse effect, and in particular on:

- modeling of the links between the environment, resources and development patterns over the long term.

- the capacity of tax incentives to stir technical change and changes in the organization of space and transportation; their macro-economic impacts,

- institutions and the implementation of decisions on the international management of the global environment.

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[1]Global Ocean Ecosystem Dynamics

Around twenty teams gathered for the most part within a research group ("GDR OIKIA") are involved in this program.

1.3. Funding and human means

All funding available to the organizations can be broken-down into research funds, that include semi-heavy equipment, lab support and program incitement actions and consolidated funding which are part of the support for these programs, and which includes the salaries of the research personnel and the technicians.

The total funding for incitement research funds reached 150 MMF in 1993 and remains mostly stable. Their objective is to structure research and instill a dynamic push towards priority programs. All of the financing show a good balance between actions related to the climate ("PNEDC, PATOM") atmospheric chemistry (PNCO and PNRCO") and ecosystems. 950 researchers and technicians are involved in these programs, for an annual budget of 560 MMF. The total consolidated budget including Space was 1,500 MMF in 1993. No recent assessment has been made.

Financing from the EEC (Environment and Climate programs and MAST II within the scope of the 3rd and 4th RTD Framework Program "PCRD" reached 50 MMF / year as a yearly average over the 1992-96 period. The annual French contribution to the IGBP secretariat in Stockholm reached 0.5 MMF (though 1996 budgetary restriction did not allow the level to be attained). Moreover, two International Bureaus are located in France, SPARC/WCRP in Verrières-le Buission and DIS[1]/IGBP in Toulouse, which corresponds to financing by the host organizations of 0.47 MMF et 1 MMF respectively.

2. Research related to mitigation

2.1. "ADEME's" programs

The "ADEME's" mission is to conduct and stir technological research in the field of new and renewable energy.

The major directions of "ADEME's" work are the following (with indications of the funds spent from the Agency's budget from 1990 to 1996):

- New and renewable energy (305 MFF)
  - decentralized electricity, essentially photovoltaics
  - biomass with studies on developing resources (short rotation forestry), on the transformation of biomass into energy and improvement of wood boilers
  - geothermal studies in particular in dry and warm deep rock (4,000 m)

- Energy savings in industry (210 MFF)
  - improving exchangers and boilers
  - efficient use of electricity in particular for high-temperature heating or as radiant energy

[1]Data and Information System

- studies on processes in particular in the iron and steel industry (furnaces, galvanizing, recycling smelting sands...) paper mills (drying) and agrofood industry (liquid solid separations).

- Controlling energy use in transportation (263 MFF)
  - actions on transportation demand (understanding determinant factors of mobility)
  - developing the attractiveness of more efficient modes, other than automobiles
  - improving traffic conditions and vehicle performances
  - developing combined transportation methods

- Controlling energy use in construction (180 MFF)
  - improving materials
  - improving heating and air renewal systems
  - researching the more efficient specific uses of electricity (in particular lighting)

70% of these funds support private research, 30% public research with an average subsidy rate of 45%.

2.2. Research on preventing the greenhouse effect in the rural sector

The level and conditions of the emissions (or sequestration) of greenhouse gases linked with rural activities are not well known enough to permit, as of now, organizing economically justified prevention actions.

A research program was therefore launched on this issue, with a special focus on the following items:

- soil carbon sequestration depending on its use and in particular carbon sequestration in forestry soils, and specifically, the study of soil changes when shifting form farming to forestry use,

- methane emissions caused by enteric fermentation of ruminant animals: empirical study of the general laws linking methane production to feeding factors and animal factors, study of the action of the various chemical or biological additives known to have a negative effect on methane generation, characterization and impact of changes in the flora in the first stomachs of ruminants thanks to mechanistic modeling and *in vitro* and *in vivo* experimental studies,

- methane emissions linked to animal waste management, including measurement of emissions in the various livestock farming systems and for various types of animal waste management, completed with technical-economic assessments of the various strategies for the reduction of these emissions,

- microbiological studies of soil methane emissions, with a focus on characterization, quantification and the ecology of methane feeding microflora which are not well known,

- flow of non-point source nitrous oxide and methane from soils, with the objective of first perfecting reliable measuring methods that are easy to implement on a large scale (it was agreed to select micrometeorological methods first since these have proven reliable for measuring in similar fields).

Measures implemented

The National Agronomic Research Institute ensures the coordination of a research program in which various public research organizations participate. This program was launched in 1992 and was granted over the 1992/1996 period 12 MFF in incitement funding allowing the implementation of overall public means of around 45 MFF. This program will be pursued until 2000.

Anticipated results

It is hoped that the results obtained by these research programs will permit the implementation of prevention measures in the rural sector which will limit gross emissions and significantly increase sinks, but their effect will mostly be felt beyond the year 2000.

APPENDIX I

GREENHOUSE GAS EMISSIONS' INVENTORY

IPCC TABLE 7A - SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

Estimation from CORINAIR National Annual Data, allocated to IPCC Source and Sink Categories

FRANCE_M+O 1990

Edited on 26/03/98

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*EMISSION ESTIMATES*						
	CO2	**CH4**	**N2O**	**NOx**	**CO**	**NMVOC**	**SO2**
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
NATIONAL TOTALS	**345161**	**3016.898**	**181.721**	**1909.473**	**11354.729**	**3155.591**	**1347.632**
1 All Energy (Fuel Combustion + Fugitive)	**356691**	**494.940**	**14.364**	**1861.522**	**10422.790**	**1853.359**	**1288.214**
A Fuel Combustion	356259	162.763	14.335	1855.957	10417.791	1724.664	1193.548
1 Energy and Transformation Industries	81881	1.299	2.286	153.278	18.051	3.587	501.171
2 Industry (ISIC)	49597	6.775	3.624	182.825	650.700	13.490	315.842
3 Transport	124921	23.877	4.025	1163.039	7759.789	1416.567	155.474
4 Comm./Institutional, Residential, Agri./Forestry/Fishing	99860	130.811	4.401	356.814	1989.250	291.020	221.061
5 Other Combustion Activities	0	0.000	0.000	0.000	0.000	0.000	0.000
B Fugitive Emissions from Fuels	432	332.177	0.029	5.565	4.999	128.695	94.666
1 Solid Fuels	0	206.258	0.000	0.000	4.255	1.064	0.000
2 Oil and Natural Gas Fuels	432	125.919	0.029	5.565	0.743	127.632	94.666
2 Industrial Processes	**16638**	**2.588**	**89.990**	**23.198**	**650.488**	**86.364**	**44.137**
3 Solvent and Other Product Use	**2284**	**0.000**	**1.912**	**0.000**	**0.000**	**732.851**	**0.000**
4 Agriculture	**0**	**1626.494**	**54.459**	**0.000**	**0.000**	**11.177**	**0.000**
A Enteric Fermentation	0	1430.388	0.000	0.000	0.000	0.000	0.000
B Manure Management	0	168.090	0.000	0.000	0.000	0.000	0.000
C Rice Cultivation	0	8.672	0.075	0.000	0.000	0.000	0.000
D Agricultural Soils	0	19.343	54.384	0.000	0.000	11.177	0.000
E Prescribed Burning of Savannas	0	0.000	0.000	0.000	0.000	0.000	0.000
F Field Burning of Agricultural Residues	0	0.000	0.000	0.000	0.000	0.000	0.000
G Other Agriculture Activities	0	0.000	0.000	0.000	0.000	0.000	0.000
5 Land Use Change & Forestry	**-33218**	**92.640**	**17.870**	**0.847**	**49.732**	**448.260**	**0.000**
A Wood & Woody Biomass Stock Change	-37899	0.000	0.000	0.000	0.000	0.000	0.000
B Forest and Grassland Conversion	13729	3.409	0.024	0.847	49.732	4.158	0.000
C Abandonment of Managed Lands	-9048	0.000	0.000	0.000	0.000	0.000	0.000
D Other Land Use Change Activities	0	89.231	17.846	0.000	0.000	444.102	0.000
6 Waste	**2766**	**800.237**	**3.124**	**23.905**	**231.719**	**23.579**	**15.280**
A Solid Waste Disposal on Land	0	757.855	0.000	0.000	0.000	4.797	0.000
B Wastewater Treatment	1314	15.756	1.918	0.000	0.000	3.022	0.000
C Waste Incineration	1452	14.247	1.207	23.905	231.719	8.149	15.280
D Other Waste	0	12.379	0.000	0.000	0.000	7.610	0.000
7 Other	**0**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
International Aviation and Marine (not included in national totals)	17485	0.000	0.255	223.741	25.053	80.340	146.001

Note : Minus values of CO2 relate to carbon uptake.

IPCC TABLE 7A - SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

Estimation from CORINAIR National Annual Data, allocated to IPCC Source and Sink Categories

FRANCE_M+O 1991

Edited on 26/03/98

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*EMISSION ESTIMATES*						
	CO2	**CH4**	**N2O**	**NOx**	**CO**	**NMVOC**	**SO2**
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
NATIONAL TOTALS	**369276**	**3003.027**	**180.368**	**1994.181**	**11584.279**	**3109.411**	**1446.166**
1 All Energy (Fuel Combustion + Fugitive)	**379250**	**519.866**	**15.517**	**1947.988**	**10681.188**	**1896.298**	**1388.644**
A Fuel Combustion	378539	192.350	15.365	1943.244	10676.135	1764.155	1300.547
1 Energy and Transformation Industries	92098	1.383	2.585	195.041	20.175	4.160	600.928
2 Industry (ISIC)	49464	6.526	3.529	202.323	632.241	17.363	309.673
3 Transport	126844	23.631	4.266	1174.937	7651.862	1406.347	161.685
4 Comm./Institutional, Residential, Agri./Forestry/Fishing	110134	160.810	4.986	370.943	2371.858	336.284	228.261
5 Other Combustion Activities	0	0.000	0.000	0.000	0.000	0.000	0.000
B Fugitive Emissions from Fuels	711	327.517	0.151	4.744	5.053	132.143	88.097
1 Solid Fuels	0	191.512	0.000	0.000	4.154	1.039	0.000
2 Oil and Natural Gas Fuels	711	136.004	0.151	4.744	0.899	131.105	88.097
2 Industrial Processes	**15871**	**1.587**	**87.712**	**20.088**	**621.126**	**78.888**	**40.304**
3 Solvent and Other Product Use	**2033**	**0.000**	**1.929**	**0.000**	**0.000**	**652.382**	**0.000**
4 Agriculture	**0**	**1596.716**	**53.821**	**0.000**	**0.000**	**10.708**	**0.000**
A Enteric Fermentation	0	1400.825	0.000	0.000	0.000	0.000	0.000
B Manure Management	0	167.487	0.000	0.000	0.000	0.000	0.000
C Rice Cultivation	0	9.057	0.078	0.000	0.000	0.000	0.000
D Agricultural Soils	0	19.346	53.743	0.000	0.000	10.708	0.000
E Prescribed Burning of Savannas	0	0.000	0.000	0.000	0.000	0.000	0.000
F Field Burning of Agricultural Residues	0	0.000	0.000	0.000	0.000	0.000	0.000
G Other Agriculture Activities	0	0.000	0.000	0.000	0.000	0.000	0.000
5 Land Use Change & Forestry	**-30791**	**94.049**	**18.152**	**0.847**	**49.732**	**450.026**	**0.000**
A Wood & Woody Biomass Stock Change	-35445	0.000	0.000	0.000	0.000	0.000	0.000
B Forest and Grassland Conversion	13293	3.409	0.024	0.847	49.732	4.158	0.000
C Abandonment of Managed Lands	-8639	0.000	0.000	0.000	0.000	0.000	0.000
D Other Land Use Change Activities	0	90.640	18.128	0.000	0.000	445.868	0.000
6 Waste	**2913**	**790.809**	**3.237**	**25.259**	**232.233**	**21.109**	**17.218**
A Solid Waste Disposal on Land	0	749.690	0.000	0.000	0.000	4.918	0.000
B Wastewater Treatment	1344	13.493	1.962	0.000	0.000	0.009	0.000
C Waste Incineration	1569	14.668	1.275	25.259	232.233	8.172	17.218
D Other Waste	0	12.957	0.000	0.000	0.000	8.009	0.000
7 Other	**0**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
International Aviation and Marine (not included in national totals)	16793	0.000	0.265	221.366	24.449	82.889	148.862

Note : Minus values of CO2 relate to carbon uptake.

IPCC TABLE 7A - SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

Estimation from CORINAIR National Annual Data, allocated to IPCC Source and Sink Categories

FRANCE_M+O 1992

Edited on 26/03/98

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*EMISSION ESTIMATES*						
	CO2	**CH4**	**N2O**	**NOx**	**CO**	**NMVOC**	**SO2**
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
NATIONAL TOTALS	**368201**	**2937.300**	**174.351**	**1926.399**	**11051.034**	**3042.875**	**1278.089**
1 All Energy (Fuel Combustion + Fugitive)	**375714**	**505.461**	**15.557**	**1883.308**	**10158.177**	**1838.985**	**1223.179**
A Fuel Combustion	375494	180.971	15.418	1876.785	10153.219	1714.800	1137.079
1 Energy and Transformation Industries	84356	1.345	2.360	175.569	18.954	4.128	480.391
2 Industry (ISIC)	51963	7.329	3.638	164.414	603.976	12.477	276.649
3 Transport	129609	23.868	4.506	1180.411	7329.226	1383.929	167.715
4 Comm./Institutional, Residential, Agri./Forestry/Fishing	109566	148.428	4.913	356.391	2201.063	314.266	212.324
5 Other Combustion Activities	0	0.000	0.000	0.000	0.000	0.000	0.000
B Fugitive Emissions from Fuels	220	324.490	0.139	6.523	4.959	124.185	86.100
1 Solid Fuels	0	194.170	0.000	0.000	4.104	1.026	0.000
2 Oil and Natural Gas Fuels	220	130.320	0.139	6.523	0.855	123.159	86.100
2 Industrial Processes	**21342**	**2.382**	**82.509**	**15.637**	**609.536**	**86.162**	**37.737**
3 Solvent and Other Product Use	**2008**	**0.000**	**1.945**	**0.000**	**0.000**	**644.269**	**0.000**
4 Agriculture	**0**	**1563.216**	**52.999**	**0.000**	**0.000**	**10.449**	**0.000**
A Enteric Fermentation	0	1366.218	0.000	0.000	0.000	0.000	0.000
B Manure Management	0	167.544	0.000	0.000	0.000	0.000	0.000
C Rice Cultivation	0	10.065	0.086	0.000	0.000	0.000	0.000
D Agricultural Soils	0	19.389	52.913	0.000	0.000	10.449	0.000
E Prescribed Burning of Savannas	0	0.000	0.000	0.000	0.000	0.000	0.000
F Field Burning of Agricultural Residues	0	0.000	0.000	0.000	0.000	0.000	0.000
G Other Agriculture Activities	0	0.000	0.000	0.000	0.000	0.000	0.000
5 Land Use Change & Forestry	**-34259**	**93.142**	**17.971**	**0.847**	**49.732**	**441.435**	**0.000**
A Wood & Woody Biomass Stock Change	-39355	0.000	0.000	0.000	0.000	0.000	0.000
B Forest and Grassland Conversion	13489	3.409	0.024	0.847	49.732	4.158	0.000
C Abandonment of Managed Lands	-8393	0.000	0.000	0.000	0.000	0.000	0.000
D Other Land Use Change Activities	0	89.733	17.947	0.000	0.000	437.277	0.000
6 Waste	**3396**	**773.098**	**3.372**	**26.607**	**233.589**	**21.575**	**17.173**
A Solid Waste Disposal on Land	0	728.128	0.000	0.000	0.000	4.935	0.000
B Wastewater Treatment	1368	16.304	1.996	0.000	0.000	0.009	0.000
C Waste Incineration	2028	15.101	1.376	26.607	233.589	8.202	17.173
D Other Waste	0	13.566	0.000	0.000	0.000	8.429	0.000
7 Other	**0**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
International Aviation and Marine (not included in national totals)	17059	0.000	0.256	220.291	26.510	81.777	137.428

Note : Minus values of CO2 relate to carbon uptake.

IPCC TABLE 7A - SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

Estimation from CORINAIR National Annual Data, allocated to IPCC Source and Sink Categories

FRANCE_M+O 1993

Edited on 26/03/98

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*EMISSION ESTIMATES*						
	CO2	**CH4**	**N2O**	**NOx**	**CO**	**NMVOC**	**SO2**
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
NATIONAL TOTALS	**333275**	**2921.826**	**163.903**	**1814.452**	**10494.107**	**2903.612**	**1151.114**
1 All Energy (Fuel Combustion + Fugitive)	**355870**	**516.677**	**15.322**	**1774.309**	**9626.351**	**1774.184**	**1101.649**
A Fuel Combustion	355373	178.274	15.177	1767.548	9621.746	1649.816	1019.869
1 Energy and Transformation Industries	69946	1.230	1.956	128.723	16.597	3.793	381.847
2 Industry (ISIC)	50076	7.114	3.463	161.338	547.521	12.235	277.174
3 Transport	129968	23.078	4.964	1151.580	6911.410	1328.518	169.992
4 Comm./Institutional, Residential, Agri./Forestry/Fishing	105383	146.852	4.794	325.907	2146.218	305.270	190.855
5 Other Combustion Activities	0	0.000	0.000	0.000	0.000	0.000	0.000
B Fugitive Emissions from Fuels	497	338.403	0.145	6.760	4.605	124.368	81.780
1 Solid Fuels	0	208.524	0.000	0.000	3.823	0.956	0.000
2 Oil and Natural Gas Fuels	497	129.879	0.145	6.760	0.781	123.412	81.780
2 Industrial Processes	**14025**	**2.116**	**74.938**	**13.562**	**585.191**	**72.288**	**32.924**
3 Solvent and Other Product Use	**1912**	**0.000**	**1.954**	**0.000**	**0.000**	**613.323**	**0.000**
4 Agriculture	**0**	**1553.502**	**50.387**	**0.000**	**0.000**	**9.173**	**0.000**
A Enteric Fermentation	0	1353.944	0.000	0.000	0.000	0.000	0.000
B Manure Management	0	169.139	0.000	0.000	0.000	0.000	0.000
C Rice Cultivation	0	10.828	0.091	0.000	0.000	0.000	0.000
D Agricultural Soils	0	19.592	50.296	0.000	0.000	9.173	0.000
E Prescribed Burning of Savannas	0	0.000	0.000	0.000	0.000	0.000	0.000
F Field Burning of Agricultural Residues	0	0.000	0.000	0.000	0.000	0.000	0.000
G Other Agriculture Activities	0	0.000	0.000	0.000	0.000	0.000	0.000
5 Land Use Change & Forestry	**-41729**	**93.089**	**17.960**	**0.847**	**49.732**	**412.582**	**0.000**
A Wood & Woody Biomass Stock Change	-46658	0.000	0.000	0.000	0.000	0.000	0.000
B Forest and Grassland Conversion	13529	3.409	0.024	0.847	49.732	4.158	0.000
C Abandonment of Managed Lands	-8600	0.000	0.000	0.000	0.000	0.000	0.000
D Other Land Use Change Activities	0	89.680	17.936	0.000	0.000	408.424	0.000
6 Waste	**3197**	**756.443**	**3.342**	**25.734**	**232.833**	**22.061**	**16.541**
A Solid Waste Disposal on Land	0	711.051	0.000	0.000	0.000	4.998	0.000
B Wastewater Treatment	1390	15.912	2.029	0.000	0.000	0.009	0.000
C Waste Incineration	1807	14.792	1.312	25.734	232.833	8.183	16.541
D Other Waste	0	14.689	0.000	0.000	0.000	8.871	0.000
7 Other	**0**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
International Aviation and Marine (not included in national totals)	17894	0.000	0.249	224.226	28.446	80.649	144.048

Note : Minus values of CO2 relate to carbon uptake.

IPCC TABLE 7A - SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

Estimation from CORINAIR National Annual Data, allocated to IPCC Source and Sink Categories

FRANCE_M+O 1994

Edited on 26/03/98

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*EMISSION ESTIMATES*						
	CO2	**CH4**	**N2O**	**NOx**	**CO**	**NMVOC**	**SO2**
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
NATIONAL TOTALS	**326733**	**2860.475**	**168.407**	**1793.777**	**9657.721**	**2865.420**	**1104.297**
1 All Energy (Fuel Combustion + Fugitive)	**353277**	**495.432**	**16.164**	**1752.165**	**8771.242**	**1671.360**	**1054.062**
A Fuel Combustion	350329	161.391	15.917	1744.544	8767.073	1551.516	984.908
1 Energy and Transformation Industries	63901	1.199	1.796	128.555	16.262	3.727	360.556
2 Industry (ISIC)	53000	7.993	3.725	167.751	599.219	12.704	287.712
3 Transport	132815	22.236	5.879	1133.674	6228.243	1257.566	165.814
4 Comm./Institutional, Residential, Agri./Forestry/Fishing	100613	129.963	4.516	314.564	1923.348	277.519	170.826
5 Other Combustion Activities	0	0.000	0.000	0.000	0.000	0.000	0.000
B Fugitive Emissions from Fuels	2948	334.041	0.247	7.621	4.169	119.844	69.154
1 Solid Fuels	0	212.936	0.000	0.000	3.472	0.868	0.000
2 Oil and Natural Gas Fuels	2948	121.105	0.247	7.621	0.696	118.976	69.154
2 Industrial Processes	**14335**	**2.425**	**77.381**	**11.365**	**602.553**	**77.591**	**29.963**
3 Solvent and Other Product Use	**1945**	**0.000**	**1.963**	**0.000**	**0.000**	**624.154**	**0.000**
4 Agriculture	**0**	**1555.516**	**51.490**	**0.000**	**0.000**	**10.349**	**0.000**
A Enteric Fermentation	0	1353.848	0.000	0.000	0.000	0.000	0.000
B Manure Management	0	169.619	0.000	0.000	0.000	0.000	0.000
C Rice Cultivation	0	12.425	0.107	0.000	0.000	0.000	0.000
D Agricultural Soils	0	19.624	51.383	0.000	0.000	10.349	0.000
E Prescribed Burning of Savannas	0	0.000	0.000	0.000	0.000	0.000	0.000
F Field Burning of Agricultural Residues	0	0.000	0.000	0.000	0.000	0.000	0.000
G Other Agriculture Activities	0	0.000	0.000	0.000	0.000	0.000	0.000
5 Land Use Change & Forestry	**-46353**	**92.544**	**17.851**	**0.847**	**49.732**	**456.299**	**0.000**
A Wood & Woody Biomass Stock Change	-50684	0.000	0.000	0.000	0.000	0.000	0.000
B Forest and Grassland Conversion	13301	3.409	0.024	0.847	49.732	4.158	0.000
C Abandonment of Managed Lands	-8970	0.000	0.000	0.000	0.000	0.000	0.000
D Other Land Use Change Activities	0	89.135	17.827	0.000	0.000	452.141	0.000
6 Waste	**3528**	**714.558**	**3.558**	**29.399**	**234.194**	**25.667**	**20.271**
A Solid Waste Disposal on Land	0	666.927	0.000	0.000	0.000	4.932	0.000
B Wastewater Treatment	1412	16.812	2.061	0.000	0.000	3.154	0.000
C Waste Incineration	2117	15.938	1.497	29.399	234.194	8.246	20.271
D Other Waste	0	14.881	0.000	0.000	0.000	9.336	0.000
7 Other	**0**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
International Aviation and Marine (not included in national totals)	16140	0.000	0.221	200.615	27.804	73.322	124.351

Note : Minus values of CO2 relate to carbon uptake.

IPCC TABLE 7A - SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

Estimation from CORINAIR National Annual Data, allocated to IPCC Source and Sink Categories

FRANCE_M+O 1995

Edited on 26/03/98

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*EMISSION ESTIMATES*						
	CO2	**CH4**	**N2O**	**NOx**	**CO**	**NMVOC**	**SO2**
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
NATIONAL TOTALS	**338545**	**2844.141**	**173.486**	**1778.056**	**9469.062**	**2770.311**	**1047.624**
1 All Energy (Fuel Combustion + Fugitive)	**363925**	**519.861**	**17.016**	**1735.667**	**8589.632**	**1639.801**	**997.484**
A Fuel Combustion	356588	187.357	16.856	1730.659	8585.425	1518.048	922.853
1 Energy and Transformation Industries	67645	1.266	1.946	142.143	17.140	3.904	377.528
2 Industry (ISIC)	52564	7.162	3.461	166.344	568.174	12.104	265.726
3 Transport	134623	21.139	6.714	1086.891	5696.692	1178.216	135.708
4 Comm./Institutional, Residential, Agri./Forestry/Fishing	101756	157.791	4.735	335.281	2303.419	323.824	143.891
5 Other Combustion Activities	0	0.000	0.000	0.000	0.000	0.000	0.000
B Fugitive Emissions from Fuels	7337	332.504	0.160	5.008	4.206	121.753	74.632
1 Solid Fuels	0	211.015	0.000	0.000	3.463	0.866	0.000
2 Oil and Natural Gas Fuels	7337	121.489	0.160	5.008	0.743	120.887	74.632
2 Industrial Processes	**15866**	**2.669**	**80.352**	**10.821**	**594.762**	**77.488**	**29.869**
3 Solvent and Other Product Use	**1792**	**0.000**	**1.971**	**0.000**	**0.000**	**574.880**	**0.000**
4 Agriculture	**0**	**1551.219**	**52.631**	**0.000**	**0.000**	**10.452**	**0.000**
A Enteric Fermentation	0	1359.210	0.000	0.000	0.000	0.000	0.000
B Manure Management	0	160.696	0.000	0.000	0.000	0.000	0.000
C Rice Cultivation	0	11.687	0.102	0.000	0.000	0.000	0.000
D Agricultural Soils	0	19.626	52.528	0.000	0.000	10.452	0.000
E Prescribed Burning of Savannas	0	0.000	0.000	0.000	0.000	0.000	0.000
F Field Burning of Agricultural Residues	0	0.000	0.000	0.000	0.000	0.000	0.000
G Other Agriculture Activities	0	0.000	0.000	0.000	0.000	0.000	0.000
5 Land Use Change & Forestry	**-46801**	**91.986**	**17.851**	**0.847**	**49.732**	**444.739**	**0.000**
A Wood & Woody Biomass Stock Change	-51165	0.000	0.000	0.000	0.000	0.000	0.000
B Forest and Grassland Conversion	13289	2.851	0.024	0.847	49.732	4.158	0.000
C Abandonment of Managed Lands	-8925	0.000	0.000	0.000	0.000	0.000	0.000
D Other Land Use Change Activities	0	89.135	17.827	0.000	0.000	440.581	0.000
6 Waste	**3764**	**678.406**	**3.666**	**30.722**	**234.936**	**22.950**	**20.272**
A Solid Waste Disposal on Land	0	629.400	0.000	0.000	0.000	4.847	0.000
B Wastewater Treatment	1433	17.069	2.093	0.000	0.000	0.008	0.000
C Waste Incineration	2330	16.347	1.573	30.722	234.936	8.270	20.272
D Other Waste	0	15.590	0.000	0.000	0.000	9.825	0.000
7 Other	**0**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
International Aviation and Marine (not included in national totals)	16815	0.000	0.228	208.204	28.999	75.682	130.627

Note : Minus values of CO2 relate to carbon uptake.

APPENDIX II

SUMMARY OF THE POLICIES AND MEASURES FOR MITIGATING CLIMATE CHANGE

CO_2									
Title of the policy/measure	Type of measure	Objective and/or emission reduction method	Sector	Degree of implementation	Estimate of the effects (MMTC)				Monitoring: indicator of the state of progress
					2000	2005	2010	2020	
New residential	Regulations	Improving energy-efficiency	Buildings	Underway	0.01	0.04	0.08	0.14	Technical solutions were changed
New commercial /institutional	Information and training Regulations	Improving energy-efficiency	Buildings	Underway	0.2	0.3	0.4	0.8	Sectoral guides were published
Existing buildings	Law	Listing building consumption	Buildings	Decided	included here	included here	included here	included here	Law on air and the rational energy use of DEC/30/96
	Economic instrument	Encourage energy control works	Buildings	Underway	0.4	0.6	1.0	1.8	2.5 billion French francs in 1992
		Energy savings programs in State buildings	Buildings	Underway	0.2	0.2	0.2	0.2	Circular of the Prime Minister of JAN/24/91.
	Economic instrument	CO_2 emissions taxation	Buildings	Proposal (decision to be taken at the EU level)	-	-	-	-	Memorandum of APR/18/94

CO_2									
Title of the policy/measure	Type of measure	Objective and/or emission reduction method	Sector	Degree of implementation	Estimate of the effects (MMTC)				Monitoring: indicator of the state of progress
					2000	2005	2010	2020	
Developing timber use in construction	Information, public support for research, regulatory provision	Carbon sequestration outside forests, reduction in fossil CO_2 emissions	Buildings	Underway			0.7		Law on air and the rational energy use of DEC/30/96
Voluntary agreements	Voluntary agreements	Energy efficiency, energy substitution	Industry	Underway	1.2	1.2	1.2	1.2	Monitoring procedure included in the commitments
Supporting measures	Financial and tax incentives	Energy efficiency	Industry	Underway	ε	ε	0.1	0.2	1996 Budget Law
Technical provisions on heavy trucks	Regulations	Reducing specific heavy-truck emissions	Transportation	Applied (safety inspection) Proposed (limiting power to weight ratio)	0	0.4	0.4	0.5	Order of JULY/5/94
Institutional actions concerning freight transportation by road	Regulations Economic instruments	Restoring better competitive terms for freight transportation	Transportation	Underway	included here	included here	included here	included here	

CO_2									
Title of the policy/measure	Type of measure	Objective and/or emission reduction method	Sector	Degree of implementation	Estimate of the effects (MMTC)				Monitoring: indicator of the state of progress
					2000	2005	2010	2020	
Development of intermodal transportation	Multiple (institu-tional, research and development, economic instruments, etc.)	Developing alternative intermodal transportation to roads	Transportation	Underway	0.35	0.7	0.9	1.6	300 MFF effort in 1995
Reduction in consumption of new vehicles	Voluntary agreements for passenger cars	120 gCO_2/km before 2010 pour for new vehicles sold in the EU, similar trend for light trucks	Transportation	National voluntary agreement Community measures underway	0	1.4	2.8	4.7	Voluntary commitment of French manufacturers to reach 150gCO2/km in 2005
Safety inspections	Regulations	Reduction of pollutant emissions	Transportation	Applied	1.2	1.0	0.85	0.8	Orders of JAN/1/95 and JULY/5/94
Removal bonus for vehicles over ten years old	Economic instrument	Encouraging replacing old automobiles by new ones	Transportation	Applied	included here	included here	included here	included here	Measure in force from JUNE/30/95 to DEC/31/1996

Summary of policies and measures

CO_2									
Title of the policy/measure	Type of measure	Objective and/or emission reduction method	Sector	Degree of implementation	Estimate of the effects (MMTC)				Monitoring: indicator of the state of progress
					2000	2005	2010	2020	
Urban vehicles	Multiple	Developing a specifically urban vehicle	Transportation	Study	-	-	-	-	Conclusions of the working group anticipated
Alternative vehicles	Multiple, including laws	Developing alternative vehicles	Transportation	Underway	ε	ε	0.3	0.5	Law on air and the rational energy use of DEC/30/96
Urban travel	Law (requirement for local authorities to draft urban travel plans)	Optimizing urban travel	Transportation	Decided	ε	ε	0.7	1.1	Law on air and the rational energy use of DEC/30/96
High-speed trains	Multiples, including investments	Giving an alternative to the road or aircraft	Transportation	Implementation underway	0.1	0.13	0.16	0.22	Management plan of national high-speed train links (1991)
Nuclear investments	"EDF" investment decisions	Energy substitution	Electricity	Underway	12.5 to 25	idem	idem	idem	"EDF" infrastructure plan

CO_2									
Title of the policy/measure	Type of measure	Objective and/or emission reduction method	Sector	Degree of implementation	Estimate of the effects (MMTC)				Monitoring: indicator of the state of progress
					2000	2005	2010	2020	
Developing cogeneration	Regulatory provision on purchasing electricity	Energy substitution	Electricity	Underway	1.6	-	1	1.2	0.6 GW installed between 1990/1994
Reducing peak load curve	Rates, public incitements, information	Energy substitution, "DSM"	Electricity	Underway	0.35	-	0.5 to 0.8	-	30 000 TEMPO accounts in 1996, 1993 and 1996 "EDF/ADEME" agreements
Substituting electricity to fossil fuels at the end-user level	Information, "EDF" commercial policy	Energy substitution	Electricity	Underway	Included with "Industry"				Continuation of electricity/fossil fuel substitution in industry
Reducing the negative effects of electric rate adjustments	Public subsidies	Energy substitution "MDE"	Electricity	Underway	0.01	-	-	-	Public budget of 100 MFF/year available within the scope of "FACE"

CO_2									
Title of the policy/measure	Type of measure	Objective and/or emission reduction method	Sector	Degree of implementation	Estimate of the effects (MMTC)				Monitoring: indicator of the state of progress
					2000	2005	2010	2020	
Tree-planting on farmlands	Public subsides	Increasing carbon sinks	Forests	Underway	0.35	-	0.68	1.0	Public budget of 65 MFF for this action in 1995
Wind energy	Regulatory provision	Energy substitution	Renewable energy	Underway	< 0.01	0.02 to 0.04	-	-	Call for proposals by the Ministry of Industry
Wood energy	Public subsides	Energy substitution	Renewable energy	Underway	0.055	0.055	0.055	0.055	Public Budget of 150 MFF between 1995/1998; contracts signed with local authorities
Biomass fuels	Public subsides	Energy substitution	Renewable energy	Underway	0.27	-	-	-	Implementation of tax exemptions
Waste-to-energy	Legislative provision	Energy substitution	Waste	Underway	0.35	0.35	0.35	0.35	Law on waste of July 13, 1992

CH_4									
Title of the policy/measure	Type of instrument	Objective and/or emission reduction method	Sector	Degree of implementation	Estimate of the effects (1000 t CH_4)				Monitoring: indicator of the state of progress
					2000	2005	2010	2020	
Elimination of the disposal of ordinary waste	Legislative provision	Reduction in CH_4 emissions	Waste	Underway	0.16	-	0.58	0.74	Law on waste of July, 13 1992
Landfill methane recovery	Regulatory provision	Reduction in CH_4 emissions	Waste	Decided	included here	included here	included here	included here	Order being readied for publication
Leaks in natural gas networks	"GDF" investment decision	Reduction in fugitive CH_4 emissions	Energy sector	Underway	0.04	-	0.06	0.08	9,000 km of grey cast-iron pipes replaced between 1990/1995

N_2O									
Title of the policy/measure	Type of instrument	Objective and/or emission reduction method	Sector	Degree of implementation	Estimate of the effects (1000 t N_2O)				Monitoring: indicator of the state of progress
					2000	2005	2010	2020	
N_2O emissions in industry	Regulatory provisions, voluntary commitments	Reduction in N_2O emissions	Industry	Decided	74	74	74	74	Orders of the Ministry of the Environment of March 1, 1993
Control of nitrogen fertilizer spreading	Regulatory provisions, information, awareness	Reduction in N_2O emissions	Agriculture	Underway	8	-	-	-	1992 CAP reform, European directive on nitrates, law on water of January 3, 1992

APPENDIX III

ESTIMATES OF CARBON EMISSIONS LINKED TO CHANGES IN LAND-USE

In the absence of sufficient scientific data it is hard to quantify the increase in carbon stored in soils in connection with the strong trend of decreasing cropland mentioned in Section III 1-6; however these should not differ significantly in 1990 and 2000.

By contrast, the conversion of permanent grasslands or forested areas into cultivated land will lead to a decrease in soil carbon sequestration because it stimulates microbial activity in the organic matter mineralization process, and this can be quantified: studies conducted in France show that the decrease is very high for the first 2 or 3 years (rapid mineralization of pre-humid components representing 10 or 15% of initially stored carbon) and that the decrease only follows the standard kinetic deterioration model (mineralization factor of 0.015), after the initial period, on the remaining amount of organic matter. When farmland is changed to permanent grassland or forested areas, the same rapid symmetrical growth is not observed in the first years[1].

The practice of bare rotating set-asides has a negative impact on carbon sequestration in soils where on average every six years (considering the current set-aside rate) there will be no annual addition of organic matter whereas soil carbon mineralization will continue. This negative effect will be abated, on the one hand by planting non-food crops on around one-third of the theoretical set-aside acreage and, on the other, by regulatory provisions aimed a seriously limiting barren set-asides because of their negative impact on nitrogen water pollution.
Therefore, an observed impact in terms of decreased carbon sequestration in soils subject to mandatory set-asides is equal to one third of the impact that would be observed if all the acreage concerned was subject to the practice of bare set-asides.

The results listed in the table below are based, on the one hand on the kinetic deterioration presented here, and on the other on annual data on distribution in France according to soil use over the 1970-1993 period, based on annual agricultural statistics, as well as on soil-use conversion matrixes between 1982 and 1990 furnished by the TERUTI survey.

This survey shows, in particular that on an average annual basis over the period, 0.3 million hectares of forests, permanent pastures, moors and waste land were converted into cultivated land, whereas 0.17 million hectares of cultivated land reverted to forests, permanent grasslands, moors or waste land.
These estimates show, in particular that changes in land use that will occur by the year 2000 will reduce carbon emissions by 2 million tons compared with 1990[2].

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[1] The methodology implemented in this section is more sophisticated than the one chosen to calculate the inventories (Section I) for which, for reasons of congruence with the estimates carried out for other sinks and sources, the simpler methodology was applied as suggested by IPCC. The methodology is based on the results of empirical studies conducted by France and produces a more realistic estimate of the impact on carbon sequestration, of changes in land-use patterns over the decade; moreover, the two methods give very similar estimates for 1990.

[2] Furthermore, CAP reform should reduce the economic value to farmers, of intensification strategies, through nitrogen fertilization, of natural grasslands, aimed at increasing productivity, or of "excess nitrogen fertilization" actions for arable crops. And, moreover, strong available nitrogen in soils also stimulates microbial activity and tends to reduce the carbon sequestration balance in soils.
Nevertheless these phenomena remain hard to quantify considering the current state of knowledge and were therefore not taken into account in the estimate proposed here.

Net carbon emissions (in millions of tons) (1)	1990	2000	1990 - 2000 trend
lands on which a change in use results in carbon depletion (2)	3.8	1.1	-2.7
lands on which a change of results in carbon sequestration (3)	-1.4	-0.85	0.55
impact of “arable crops” set-asides	0	0.12	0.12
BALANCE	2.4	0.37	-2

(1) assuming average carbon sequestration at a respective balance of 40 and 70 tC/ha for cropland acreage and for forests, grasslands, moors and waste land.
(2) conversions of forests, permanent grasslands, moors and waste land and cultivated land.
(3) conversions of cultivated land into permanent, moors, waste land into forests as well as conversions of permanent grasslands, moors and waste land into forests.

APPENDIX IV

FRENCH CONTRIBUTION TO RESEARCH ON GLOBAL CLIMATE CHANGE

1. The National Program of Studies on Climate Dynamics ("PNEDC")

1.1. Presentation of the "PNEDC"

When the "PNEDC" was launched in the 1980s, an organized group analyzing the behavior of global climate system did not exist. The various teams, often of high scientific caliber, only had the means to study the dynamics and geochemistry of the atmosphere, oceans and ice through limited process studies.

The "PNEDC" served to focus concerted action which allowed the development and modeling of major planet fluids and integration of the data obtained during experiments aimed at better understanding the interactions forming within the various major systems that determine the Earth's climate.

The establishment of a major French climate research program led the French community to conduct an intense effort to develop models of general circulation in the atmosphere and oceans and to catch-up on its lag with the most advanced teams, in particular in the United States, Great Britain and Germany on the subject of the ocean-atmosphere-ice coupling. This latter objective is close to being reached

Many experiments calling for coupled ocean-atmosphere models were implemented to study interannual climate variability, simulate measures carried out within the scope of the International TOGA Program and prepare studies on long-term climate variability.

Simultaneously with this modeling effort, the "PNEDC" relied on the strong points of the French community to obtain observation data that atmospheric or ocean dynamics specialists could use in the models they were working on. These experiments permitted beginning the study of climate variations, of their causes and the feedback linked to annual or anthropogenic disruptions. They concern in particular:

- determining long-term climate variability by studying polar ice, marine and continental sediments,
- disturbances in the carbon dioxide cycle by human activities (in connection with the JGOFS program dedicated more specifically to the ocean bio-geo-chemistry aspects),
- analysis of the impact on the climate of the increase in concentrations of atmospheric greenhouse gases,
- studying the energy exchanges linked to the water cycle and their representation in models of general atmospheric circulation,
- the study of interactions between the tropical ocean and the atmosphere, leading within the scope of the TOGA program to the demonstration that climate can be forecasted in the tropical area affected by the El Niño phenomena,
- establishing a set of reliable data representing the current state of the ocean and allowing the description of its general circulation.

The size of the means required was such that the targeted objective could only be reached within the scope of an international coordinated effort. This was done through the WOCE program in which French teams participate principally by studying the South and equatorial Atlantic Ocean as well as the Southern part of the Indian Ocean.

It would be impossible to describe here all the results obtained over the last ten years by French teams. The emergence of an internationally recognized community, not only through its original publication in international journals with great impact, but also through its integration in the major actions and scientific committees of the World Climate Research Program and the International Geosphere-Biosphere Program. It is also reflected through the active participation in the European programs of French researchers. The few examples described here do not claim exhaustivity, but are only meant to illustrate with the help of a few recent results, the strategy implemented within the scope of the "PNEDC" to discover a few key components of climate variability and strengthen dialogue between experimenters and modelizers.

1.2. A few important results of the "PNEDC"

1.2.1. Evidence of rapid climate change

The work of French paleo-climatologists enabled achieving spectacular advances and discovering variations that had never been suspected before within the climate system, in particular changes in the content of greenhouse gases in the atmosphere linked to the natural upheavals of biogeochemical cycles and those of ocean circulation associated with minor changes in the hydrological regime.

Moreover, this research led to the discovery of periods during which the climate evolved very rapidly. Indeed, the speed with which the climate was capable of changing was not known for a very long time, because geologic records could not be dated precisely enough to estimate the real time-frame of a major climate transition. The recent possibility of reconstructing from polar ice and marine sediments climate variations on the scale of a few dozen or hundreds of years has opened totally new horizons and a series of converging studies showed the truly abrupt nature of many climate changes that may develop over periods comparable with the human life span.

1.2.2. Soil-vegetation-atmosphere transfers: from the HAPEX program to modeling

The main objective of the HAPEX program was to improve the parametrization of transfers between water and soil, vegetation and the atmosphere, in order to present the phenomena in a reliable manner on the grid scale of the general circulation models of the atmosphere, i.e., at least 100 km by 100 km. These differ significantly depending on climate conditions. This is why French participation in the HAPEX program was accomplished with three major experiments in regions experiencing very different climates: HAPEX-MOBILHY (1986) in South-West France, EFEDA (1991) in Spain, and HAPEX-Sahel (1992) in Niger.

The objective has now been reached. The HAPEX-MOBILHY operation enabled the devising of a methodology with two major stages, the study of the continental surface by remote-sensing and the implementation of parametrization on a 100 km scale. This method is currently being validated by comparison with the results of the EFEDA experiments and HAPEX-Sahel. The first results are extremely satisfactory. Two original outlines with very different points of view were developed to parameter the soil-vegetation-atmosphere transfers: SECHIBA and ISBA. The ISBA outline (Interactions Surface-Biosphere-Atmosphere) only has a limited number of entry parameters. Among these, the indication of the actual conditions on the surface is the most important. Data gathered on location during the many experiments was

needed to validate this parametrization of soil-vegetation-atmosphere transfers. In particular, validation at the 100 km scale could only be performed thanks to data from HAPEX-MOBILHY and EFEDA using the actual surface characteristics (arithmetic averages for vegetation fractions and foliar factor, logarithmic for the roughness length, harmonic for stomatal resistance,...).

1.2.3. Participation in measurements of CO_2 atmospheric content

CO_2 in the atmosphere has been recorded continuously at the Amsterdam Island station since 1980, with a precision of over 0.1 ppm. The station is located in the center of the Southern Indian Ocean, far from the Continents, where seasonal variations in the concentration of carbon dioxide in the atmosphere are very low.

This is caused by the weak fluxes transferred locally, in addition to a compensation between the effects of faraway continental vegetation with air-sea transfers, that have the opposite effect. This extremely low seasonal variation is a major help in determining the overall trend of CO_2 in the air, the growth rate of which varied between 1 and 2 ppm a year over the 1980-1990 period.

1.2.4. Absorption of anthropogenic CO_2 by the global oceans

Around half of the 5 to 6 billion tons of carbon emitted as CO_2 by fossil fuel combustion remains in the atmosphere. The other half is absorbed either by continental vegetation and soils, or by the ocean. However, knowledge of a precise balance for CO_2 is crucial to predicting the greenhouse effect in the future. Indeed, this gas is only sequestered in plants and soils for just a few decades whereas it is absorbed by the ocean, and should stay there much longer, regardless of future climate trends.

Anthropogenic carbon dioxide mixes with CO_2 already present in the atmosphere, and it is impossible to directly measure its outcome, or the fluxes transferred between the air and ocean, or between the air and the continental biosphere. It is therefore necessary to refer to modeling. Until now, simulations carried out with general ocean circulation models suggested, since 1950, that the ocean pump was not powerful enough to absorb all CO_2 produced by human activities, without even taking into account deforestation. It was therefore traditionally accepted that the balance would not be at equilibrium unless a biosphere sink (forests and soils) intervened. This result was surprising, since the growth of preserved forests and carbon sequestration in soils were to compensate both deforestation and a portion of industrial combustion.

This balance has just been put into question and the results obtained with the French model suggest that the role of the oceans had been underestimated.

In an overall balance, simulation with the help of this model, reveals a CO_2 ocean sink that is much greater than previous estimates. The result is that the atmospheric CO_2 content since the beginning of the industrial era can be explained by the simple intervention of the ocean pump.

1.2.5. Improvement of the consideration of average coverage in climate simulations

Increased concentrations of greenhouse gases in the atmosphere generated by human activities may in the next century cause climate warming though it is still hard to determine its extent. A

lack of full understanding of internal feedback in the atmospheric system explains to a large degree these uncertainties, which the climate dynamics scientists are striving to explain. Numeric experiments carried out in France are aimed at analyzing the weight of the physical representation of clouds in general atmospheric circulation models, in order to better assess the validity of future climate forecasts performed with these models.

Though future climate risks are well established, it remains very difficult to correctly simulate their consequences on a regional scale, in particular because clouds, by influencing the radiative balance of the atmosphere and feedback generated, are of major concern. This is why the consequences of a doubling in carbon dioxide concentrations in the atmosphere were simulated during two experiments carried out with the help of French general circulation models, each one only differing from the other by its physical cloud representation and taking into account the distinction between ice clouds and water clouds.

A comparing of these simulations shows that though there is very little change in average global warming, regional variations are very high and that climate structures are drastically changed.

These results illustrate the critical importance of improving the representation of cloud physics in models, and in particular the microphysical processes that determine in the first place the optical characteristics of these clouds. These same processes also play a crucial role in the response of the climate system to increases in sulfur aerosols. Validation of the new parametrizations can now rely on satellite measurements, such as the ones supplied by the American ERBE experiment or those of the French instrument SCaRaB.

1.2.6. Predictability of the coupled tropical ocean-global atmosphere system

The TOGA program (1985-1994) was aimed at studying the predictability of the couple formed by the tropical ocean and the global atmosphere, because recent studies carried out over several decades had suggested the existence of a logical sequence in the succession of events leading to El Niño climate episodes: a pressure rise in Australia-Indonesia and a weakening of the trade winds were combined with the failure of deep water off the coast of Peru to rise to the surface, a several degree increase in the coastal water temperatures and torrential rains over Peru. In fact, all of the inter-tropical area was affected, causing serious socioeconomic consequences (hurricanes, agriculture, fisheries,...). To reach this objective, efforts focused on the tropical Pacific Ocean. A large internationally coordinated program was launched (TOGA) and French research teams participated in three types of actions:

- defining and establishing a network of measures in the ocean and atmosphere in order to obtain the observations needed to describe the low-frequency variability of the tropical climate system,
- developing numeric models capable of describing tropical variability and assimilating the network’s observations,
- analyzing the control mechanisms and studying the predictability of the coupled system.

Among the physical mechanisms that play a role in the ocean-atmosphere coupling, and that can both be studied by analyzing data and through model simulations, two were focused on:

- Ocean wave propagation that the observation network (XBT, TAO) and altimeteric measurements in particular by the Franco-American TOPEX-Poseidon experiment, have revealed and that can also be simulated in numeric models,
- mechanisms that amplify initial anomalies, linked to the coupling between surface water temperature, currents and winds. Understanding was sought of the role of Westerly gusts in the initiation phases of El Niño. These occur very frequently from November to April in the Western Pacific equatorial area. The COARE (Coupled Ocean Atmosphere Response) showed that these gusts are in fact evidence, on the ocean surface, of strong convective events in the atmosphere. This produces not only a dynamic ocean-atmosphere coupling but also heat and fresh water transfers. Accompanying strong rainfall can create a desalinated surface layer that limits ocean-atmosphere transfers in an area with very low vertical range which could lead to an increase in the coupling. It was possible to simulate the contrast between surface salinity during the El Niño event and the cold event of 1988 with help from the French ocean model with input from the surface atmospheric conditions deduced from the analyses of the European Medium-Term Forecasting Center.

2. THE OCEAN FLUX PROGRAM ("PFO" or JGOFS-France)

The scientific objectives of the French JGOFS-France program fit in naturally with the international JGOFS program which is itself a component of the IGBP program.

The objectives are: acquiring a good understanding of the ocean carbon cycle and quantifying the carbon transfers with the atmosphere, ocean floors and the continents.

To reach these, four approaches have been selected:

a) process studies,
b) continuous series of observations from a fixed location,
c) establishing a global inventory of CO_2 dissolved concentrations on the ocean surface,
d) developing realistic models that also include models of data assimilation methods.

At the French level, the same approaches were followed, but within the scope of two national programs, on the one hand the "PNEDC" CO_2 sub-program within which items c) and d) were studied (see previous Section) and on the other the JGOFS-France program within which points a), b) and d) were developed.

The international JGOFS program was established in 1987. Its experimental phase will end in 1999. Its final phase, concerning aspects of synthesis and modeling will end in 2004.

The time-table for the French contribution to JGOFS follows closely that of the international program.

The French program's content is summarized below with reference to the presentation of the international program that was just described above.

2.1. Process studies

These rely on two series of ocean programs. Five major actions have been or will be conducted. These are:

EUMELI: the study of eutrophic, mesotrophic and oligotrophic areas in the Tropical Atlantic Ocean, a region close to the Mauritania upwelling. Ocean expeditions will take place during the 1990-1993 period.
The scientific exploitation of this program is nearly completed and has generated a number of important publications in the best international journals.

EPOPE: this is the French contribution to the JGOFS program in the equatorial Pacific based on a strong American and a Japanese contribution. Work at sea took place in the Western Equatorial Pacific during the fall of 1994. Scientific exploitation is nearly completed.

FRONTAL: this action concerns the study of hydrological fronts whose specific characteristic are to serve as highly energetic interfaces with their own ecosystems, generally offering significantly higher biological productivity. French teams have focused their efforts on the study of the Almeria-Oran front in the Mediterranean. An initial campaign took place in 1991. Analysis and interpretation of the data acquired served as a basis for many publications and led to, in view of the conclusion reached, the planning of a second campaign that will take place in November-December 1997. This will be the last experimental phase of the FRONTAL program.

ANTARES: the Antares operation of JGOFS-France is aimed at describing and modeling the carbon cycle and associated biogenous elements in the Antarctic sector of the Indian Ocean. It relies on a series of campaigns implementing the oceanographic vessel Marion-Dufresne. Three campaigns took place during 1993, 1994 and 1995. Scientific exploitation of these campaigns is underway. A final campaign, more focused on the study of a front, has been requested for 1998. This will also be the end of the experimental program.

"ATLANTIQUE NORD": this is the last JGOFS-France program. Its purpose its to study the influence of medium-scale processes, at the physics as well as bio-geo-chemistry levels, of the formation and subduction of modal waters around 40° N in the North Atlantic. This program will be jointly led within the scope of "PATOM" and the JGOFS-France. It will rely on an ocean program to scheduled for 1999 or 2000.
This program will conclude the experimental phase of the process studies carried out within the scope of the JGOFS-France program.

2.2. Time series

KERFIX: this is a station located at a fixed point in the Southwest quarter of the Kerguelen Islands (50°40 S - 68°25 E) in the Southern Indian Ocean. A regular multi-annual monitoring of carbon cycle parameters is planned. The data was collected between January 1990 and March 1995, after which all sampling was ended because of major logistical problems required to maintain the program.
All the data collected at Kerfix will be available to the scientific community in 1997.

DYFAMED : operation Dyfamed is a long-term study of the Mediterranean environment focused on observation and forecasting of biogeochemical carbon cycles and related substances. The observation site is located 30 miles at sea from Nice on a line between Nice and Calvi. The data have been gathered on a monthly basis since 1991. Operations at this site will continue, since this action of JGOFS-France is now labelized "Observation Service of "INSU" (the French Institute of World Science) since 1995.

2.3. Synthesis et modeling

This involves horizontal actions regarding all the operations described previously.

- creating a data-base, currently under construction

- use of ocean color satellite data, in particular data from the OCTS and POLDER sensors currently in orbit and in the near future SEAWIES

- developing models

A large community of young researchers has formed within the scope of the JGOFS-France program. This community has now reached a mature phase, is well structured and has good exposure at the international level. In future years, this will be a major asset in enhancing the value of the huge efforts carried out at the experimental level since the start of the JGOFS-France program in 1990.

3. NATIONAL ATMOSPHERIC CHEMISTRY PROGRAM ("PNCA")

French research in atmospheric physics and chemistry was structured in the past years around three national programs ("PACB", "PAMOY", "PNCA", "PRIMEQUAL"). In spite of incorporating specific features of the national community, the scientific objectives of these programs were defined in coordination with the major priority directions of international programs such as the International Geosphere-Biosphere Program or the European programs EUROTRAC and Environment and Climate.

Close to two hundred scientists (researchers, engineers, technicians belongs to the major research organizations and universities) are currently involved in these issues and their work has permitted major progress in many fields.

Regarding atmospheric composition, the effort of the French community has permitted a better understanding of the formation, transmission and destruction of minor types and traces of gases and particulates. Thus, French researchers have played a major role in carrying out European seasonal studies of Arctic stratospheric ozone ("EASOE", "SEAME") and in interpreting the data collected. This permitted confirmation of a decrease in stratospheric ozone in the Polar regions but also at middle latitudes.

The French community has also focused its efforts on studying trace component emissions in Africa and their effects on atmospheric composition: the programs implemented have enabled studying trace component emissions and their atmospheric transformation over a cross-section from the desert areas of Sahara (Wind Erosion Program, impact of mineral aerosol emissions on atmospheric chemistry and the climate) to the equatorial forests (DECAFE program on

quantification and changes in emissions of trace components and carbon aerosols in equatorial forests and in the African savanna area).

The French community has also significantly contributed to the study of atmospheric trends on climate time scales. The study of ice cores gathered during international campaigns in Greenland or in Antarctica confirmed that atmospheric composition in trace components responded very quickly to climate fluctuations.

Beyond these intensive studies, the French community is strongly committed to the management of long-term observation stations over on atmospheric composition trends. Most of the stations (Amsterdam Island, Haute-Provence Observatory...) are integrated into international networks (VAG, NDSC, TOR...).

Finally, France is also strongly involved in the MOZAIC program (Continuous observations of trace gas concentrations aboard commercial aircraft) in order to assess the impact of civil aviation on atmospheric composition.

Simultaneously with the experimental activities, an important effort has been made on studying chemical processes (homogeneous as well as heterogeneous) in the laboratory (designing simulation chambers, flow reactors) and on the use of coupled chemistry-transmission models.

Regarding the field of meteorology, major observation campaigns (such as “PYREX” and “FRONT”) enabled recording and improving the representation of small and medium scale phenomena in digital models. Progress was made in the models taking into account non-hydrostatic phenomena and on the development of data integration methods. The focus is now on developing operational models capable of simulating local phenomena in their consequences (convective processes, storms and major floods, local pollution peaks).

A restructuring of the programs concerning tropospheric chemistry (corresponding to the IGAC program of IGBP) and stratospheric physics and chemistry (corresponding to the SPARC of WCRP) was carried out during 1996. Therefore, the new “PNCA” program replaces the previous “PACB” and “PAMOY” programs. This new regrouping takes into account the fact that the tropopause does not act as a barrier for chemical compounds and that, in spite of substantial differences between the two environments, a number of common problems are present on both side of the tropopause.

The concerns this program must answer range from urban pollution to stratospheric ozone depletion covering all space and time scales. Awareness of the issues raised by air quality and threats to the ozone layer has already resulted in the signing of international conventions in this field, such as the Geneva Convention and the Montreal Protocol. However, many issues still remain on the changes in composition and impacts on society and require continued basic research. This is the goal for which the “PNCA”, supported by “INSU/CNRS”, “ADEME”, “CNES”, Meteo-France and the Ministry of the Environment, has outlined a strategic plan over the next 4 years.

With this plan, the French community will contribute to the research efforts undertaken in Europe (and supported in particular by the European Commission) and should offer a significant contribution to the following issues:

1. What is the role of precursors such as volatile Organic Compounds (VOCs) and nitrogen oxides (NO_x) in the ozone budget and other photo-oxidants in the troposphere on a global and regional scale?
2. What are the processes that determine the ozone budget in the region covering the upper troposphere and the lower stratosphere?
3. What is the role of heterogeneous chemistry involving aerosols and hydrometeores?
4. What is the role of dynamic barriers in the transmissions process of chemical compounds?
5. What is the contribution of chemical compounds (other than CO_2 and aerosols) in climate forcing?
6. What is the influence of the continental and ocean biosphere on the chemical composition of the atmosphere?

The set of issues fostered by the program fall within the following subjects:

I- Coupled Troposhere-Stratosphere system, with 4 sub-categories:
- Long-term trends
- Chemical processes
- Dynamic barriers
- Exploitation of the satellite data and related experiments

II- Tropospheric ozone and precursors with three priorities:
- Developing global and regional models
- Collecting data to quantify sources and sinks
- Validation of these models through field trips

Studies on urban pollution are supported, moreover, within the framework of the "PRIMEQUAL" program of " ADEME" and the Ministry of the Environment.

III- Aerosols and heterogeneous chemistry: The role of heterogeneous chemistry regarding particulates, aerosols, cloud droplets, Polar stratospheric clouds... have been fully demonstrated over the last few years, but the processes are not yet entirely understood, in particular for the troposphere. This subject will be treated through various approaches: study of the processes, modeling and *in situ* readings.

IV- Biosphere-atmosphere interactions: Atmospheric chemical composition is dominated by the activity of the continental biosphere; gas and particulates from natural and anthropogenic systems, dry and humid pollutant deposits. The program covers the following aspects:
- Measurement of surface fluxes
- Impact of emissions on atmospheric chemistry
- Experimental studies and modeling

V- Chemistry–climate interactions: The influence of carbon dioxide and aerosols is taken into consideration by the "PNEDC". But the influence of trace gases in the atmosphere cannot be ignored, in particular ozone. Radiative forcing calculation is complex because it must include feedback from climate influences on atmospheric composition. The "PNCA's" contribution is accomplished through development of chemical modules or parametrizations that must be included in the general circulation models. Moreover, the program encourages projects on the validation and integration of data obtained during field trips or systematically by the French community.

VI Laboratory research: The study of the chemical and photochemical processes taking place in the atmospheric environments calls for laboratory research in the following fields: kinetics and gaseous phase photochemistry, heterogeneous chemistry, spectroscopy.

4. National Continental Biosphere Program ("PNBC")

The "PNBC" focuses on the issue of "the environment", where humankind lives.

It is motivated by the need to answer a series of environmental questions on the development of rural space under the pressure of climate change and human activities. These will concern physical objects (mixed landscapes: their elements, ecosystems... and regional integration) and issues (primary production, nutrient balance, etc.) with the assistance of integrating tools (modeling, spatialization, on-site workshops, experimental means).

The "PNBC's" objective is:

1 promoting on a national scale a true environmental research dynamic which, on the basis of current issues, is aimed at understanding the operating processes of the continental surface and their interactions with the atmosphere and hydrosphere, and to generate scenarios of their potential trends (climate and human pressures),
2 furnish operational decision-making tools by ensuring the transmission of the scientific results to the actors of sustainable development,
3 structuring and developing the scientific community in the subject area by encouraging multi-displinary approaches (intra and inter-organization cooperation),
4 stimulating the emergence of specific issues and experimental centers of French skills and the value-enhancement of the results at the international level.

The projects of the "PNBC" are targeted missions which focus on environmental issues. Relying on up-stream specific research, that are immediately required, and must enhance the value of their acquired knowledge by cooperating with organizations that are actors in development.

The time and space scales contemplated are the ones under which environmental issues are framed. The priority space scale is the landscape, as a functional unit. Its study implies an analysis of the systems composing it and their interactions, and the transfer of the results on a regional scale. Priority is given to current dynamics, to the near future (a realistic trend scenario that can weigh on development decisions) and on the recent history conditioning the current state.

Projects must adopt an integrated approach of the functional and dynamic processes operating on relevant time-space scales and associate biological and physical variables with anthropogenic constraints.

Proposed by the Environment Program, "*Vie et Société*" of the "CNRS" with the direct support of the Department of Life Sciences, the "PNBC" combines in a coherent approach the other relevant "CNRS" Departments ("SdU" and "SHS", in particular) and the major French

research institutions, and cooperates with national, regional and local development organizations.

5. National Program "Biodiversity and Environment Dynamics"

This program launched in 1993 is managed by the *"PIR Environnement-Vie-Sociétés"*. Its has been funded on average with 2.5 MMF per years by the "CNRS" since 1994. In 1997, it will enter into its second phase for four years, as the International DIVERSITAS Program of which it is the French component.

Through the magnitude of its field of action, the "PNDBE" should be viewed as a Major Program, e.g., a programming action which coordinates several obviously inter-dependent programs. We will distinguish here, for the sake of clarity, the fields or subject directions and program subjects — which may or may not intersect several of these fields — and within these programs, operations or research actions.

5.1. Context and objectives

Signed in Rio in June 1992, the Convention on Biological Diversity calls attention in its Preamble on "the urgent need to develop scientific, technical and institutional capacities to provide the basic understanding upon which to plan and implement appropriate measures (for the preservation and sustainable use of biological diversity)".

Biological diversity offers great economic value for our societies, without mentioning its aesthetic, ethic or cultural value. Actually, modern societies depend on biological diversity as a source of medicine, fiber and food. Societies can also profit from the use of genes (resistance to pathogens, adaptation to special conditions, antibiotic production, etc.) and a variety of molecules in many biotechnology and agribusiness sectors. Moreover, the various services supplied by ecosystems, such as air purification and water sanitation, erosion protection, climate stabilization, depend in part on their specific and genetic richness.

On the international level, at the same time as the preparation of the Rio Summit, the IUBS, SCOPE and Unesco were implementing the DIVERSITAS program to respond to the requirement mentioned in the Preamble to the Convention. Subject to the aegis of the ICSU in 1996, the program has currently spread in four major directions:
- Origin, preservation and erosion of biodiversity,
- Role of biodiversity in the functioning of ecosystems,
- Inventory, classification and monitoring of biodiversity,
- Conservation, restoration and sustainable use of biodiversity.

The national program "Biodiversity and Environment Dynamics" is the French contribution to the International DIVERSITAS program. It is recognized as such by the Ministry of Higher-Education and Research and by the Ministry of the Environment. The following research organizations are involved: "CEMAGREF", "CIRAD", "CNRS", "IFREMER", "INRA", "MNHN" and "ORSTOM". Three strategic long-term objectives are assigned to the BED program:
- responding to the commitments made at Rio, within the framework of the Convention on Biological Diversity,

- affirming the unity of biology and its mobilizing role at the interface of two major scientific fields represented by the physical sciences on the one hand and the social sciences on the other.
- mobilizing the latter (sociology, economics, law, history...) to better take into account the "biodiversity/societal" interactions and the prospects of enhancing the value of biodiversity.

Within this perspective, three scientific objectives were proclaimed:
- highlight the factors that shape biodiversity and determine its modifications,
- assessing, modeling and forecasting the role of anthropogenic interventions in the dynamics of biodiversity and their impacts on the functioning of ecosystems,
- understanding and taking advantage of the value of biodiversity for human societies, whether economic, ethical or cultural.

5.2. General scientific direction

The Biodiversity and Environment Dynamics program is seeking to promote knowledge of biological diversity: origins, composition, operation, preservation and conservation. It especially encourages research that could answer the questions humankind is asking on its relations with the diversity of life, in connection with scientific knowledge, culture, health or economics.

Though there is consensus among scientists on the approaches to develop at the lower levels of organized life (molecules, cells, organs, individuals), the same is not true for the approach to the higher levels (populations, multi-specific populating, ecosystems, landscapes). This reflects a lack of knowledge regarding the relations between individuals, species and ecosystems.

Relying on the first approach to develop the second establishes an initial directional perspective for the program. Anthropogenic influences on the biosphere first concerns biodiversity, even before influencing the major geochemical climate processes. In this field it will also be necessary to rely on the proper knowledge and control of biological phenomena to contribute to the solution of the issues raised on a global planetary scale. However anthropogenic influences are not the result of a single process; its paths of action at the various levels and scales of organization of living beings are multiple and represent as many current theoretical and practical stakes. Thus, the second directional perspective of the program has been established.

The major elements of the program concern:
- the origin, preservation and erosion of biological diversity,
- the contribution of diversity to the functioning of ecosystems,
- perceptions and uses of diversity.

The implementation of the program and its possible success compared with its predetermined objectives imply the simultaneous and coordinated development of upstream and downstream research within the following major directions:
- Upstream, the program supports research aimed at establishing inventories, advances in systems engineering and the identification of interrelations between taxons.
- Downstream, the program is focused on methodological research enabling the assessment and monitoring of biodiversity and engineering research on conservation, restoration and sustainable uses of biodiversity.

In both cases the program cannot be the only or the major actor, it offers to cooperate with other operations to be piloted by the National Museum of Natural History ("MNHN"), as its principal stated mission (upstream), the Ministries of the Environment and Agriculture (downstream). Finally, focused on biodiversity dynamics perceived as an environmental issue, it is obvious that it does not just concern biologists: it is a truly inter-disciplinary program that must be promoted. The objectives of implementing the program are always difficult to accomplish, and must always be started over again: a back and forth action between knowledge of basic processes relying on concepts and theories, based on biological and socioeconomic phenomena, building models and validating them, and analyzing biological objects and systems considered in their specificity and for which the approach is aimed at controlling events and situations. Therefore the program supports very distinct fields of research and seeks, through programs and various operations (research actions, workshops, establishing research groups...) to build among them repetitive currents of exchange and integration.

The state of knowledge, of past and current activities of the scientific community, the successes and failure of operations conducted within the framework and at the instigation of the program during its initial years (1993-1995) permit the consideration for the 1997-2000 period three types of actions:
- scientific actions to be pursued and developed,
- new scientific actions to be designed and launched,
- organizational actions of the scientific community to translate into reality the exchange and integration objectives (publications, symposiums, progress reports and forecasting).

All these actions recognized and supported by the program are the result of cooperation among scientists, teams or institutions for the purpose of carrying out a specific objective. However, the program is not meant to substitute itself to formal research structures (from teams and laboratories to national institutions) that have their own mission, authority and responsibility. It not meant either to support very specialized research projects or that only partially fit within the scope of the issues defined above.

5.3. Research programs underway or being developed

The implementation of research operations in the major subject areas defined by DIVERSITAS required developing subject-based programs. These are coordinated within the "PNDBE" Major Program and must satisfy, in order to be both operational and structuring, with two types of very different constraints:

1. Implement research operations and/or structuring actions of the scientific community in fields that are deemed to have priority (directions or subject areas).
2. Avoid giving in both to divisions within the groups of specialists and to artificial regroupings under the excuse that the subject areas are very close theoretically.

Current programs are first developed as national networks. This is the basis under which the "PNDBE" Program was organized and is developing. Six networks, in various levels or forms of development, formed the initial layer:

1. The network "Biodiversity trends and preservation processes" (supervisors: B. Delay, P.H. Gouyon et J. David).
2. The network "Biodiversity perceptions, trends and uses" (supervisor: J. Weber)

3. The network "Microbial biodiversity" (supervisor: J. Balandreau)
4. The network "Ecology of Sustainable Interactions" (supervisor: M. Boulétreau)
5. The network "Ocean biodiversity" (supervisor: A. Guille et J. Boucher)
6. The network "Sub-divided populations, risks of extinction and conservation" (supervisor: J. Clobert)

Furthermore, the "PNDBE" Programming relies on two additionally implemented structures:

1 The Scientific Grouping "Genetic Resource Bureau" ("BRG"), which has been efficiently covering for several years, the crucial field of biodiversity represented by genetic resources of interest to agribusiness (Director: M. Lefort)
2 The Biosystematic National Network ("RNBS") implemented by the Research Directorate, which corresponds, at least in part, to the subject area "biodiversity inventory, classification and monitoring" of the International DIVERSITAS Program (Director: S. Tillier).

The six networks listed above have enabled the development of a number of subject-based programs. Moreover, in the "PNDBE's" second phase, partial or completely external initiatives gave rise to three new programs aimed at taking over incitement actions or workshops designed in order to prepare them:
1. Paleo-biosphere: trends and crises (supervisor: B. David et P. de Wever)
2. Biodiversity and ecosystem operations (supervisor: M. Loreau et J. Roy)
3. Management of biological resources, agro-ecosystems and landscapes, and sustainable development (supervisor to be appointed in agreement with "INRA", "CIRAD", "MNHN" "ORSTOM and "CEMAGREF").

ACRONYMS

FRENCH	:	ENGLISH TRANSLATION
ADEME	:	The French Environment and Energy Control Agency
PAC	:	Common Agricultural Policy (CAP)
CFD	:	French Development Bank
CIRAD	:	The French Center for International Cooperation for Agricultural Sciences and Development
DOM/TOM	:	The French Overseas Districts and Territories
EDF	:	*"Electricité de France",* the French Electric Utility
ENR	:	New and Renewable Energies
FACE	:	Fund for the Depreciation of Electrification Costs
GDF	:	*"Gaz de France",* the French Gas Utility
ORSTOM	:	The Overseas Territories Scientific Research Agency
PREDIT	:	Program for Research and Development for Innovation and Technology

ABBREVIATIONS

kt	:	kilo metric ton
MFF	:	millions of French francs
MMT	:	million metric tons
MMTC	:	million metric tons of carbon
MMTCE	:	million metric tons of carbon equivalent
toe	:	tons oil equivalent
t or T	:	metric tons

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